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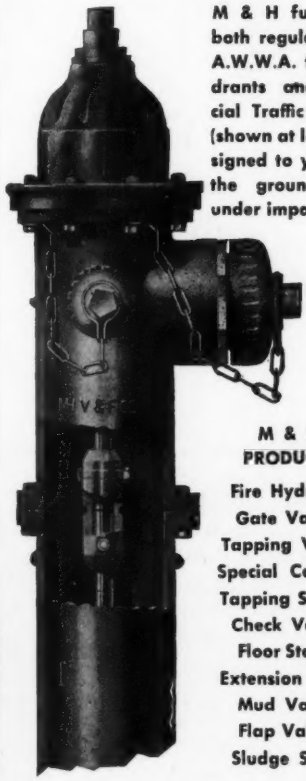

M & H furnishes both regular type A.W.W.A. fire hydrants and special Traffic Model (shown at left) designed to yield at the ground line under impact.

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Fire Hydrants
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Tapping Sleeves
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Floor Stands
Extension Stems
Mud Valves
Flap Valves
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ANNISTON, ALABAMA

PUBLIC WORKS

Founded in 1896

Devoted to the interests of the engineers and technical officials of cities, counties and states

Vol. 75 No. 6

A. PRESCOTT FOLWELL, Editor

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The reputation of Roberts Filter Company has been established on the fact that we are first of all, capable engineers. We have never deviated from this policy, regardless of the size of a job or its relative cost.

We have always operated under the assumption that those people for and with whom we work—expect us to have and to use freely our knowledge, insight, and long experience for the most efficient solution to their particular problems. Our entire personnel has been built up over a 30 year period to assure this participation-engineering to that degree required by specific circumstances.

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Many of the nation's leading consultants on water problems are using the facilities of Roberts Filter Company to aid in the detailed planning of present or future projects under their supervision. You will find the Roberts organization well informed, dependable, and cooperative in every way.

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THE WAR EMERGENCY

Reemployment of Returning Veterans

War veterans are returning to civil life in increasing numbers and it is important that those previously in Federal employment know their rights as to reemployment. And that, to enforce these rights, they must make application for reemployment "within 40 days after he is relieved from" training and service. He should be careful to thoroughly identify himself—his mere name is not sufficient; the list of veterans contains 12,000 John Smiths, and over 185,000 other Smiths, 136,000 Johnsons, 100,000 Browns, etc.

Seniority rights accumulate during the veteran's period of active service in the armed forces in the same manner as they would have accumulated had he remained continuously at work in his civilian occupation. He must be qualified to perform the duties and functions of the position which he claims; if he is not, he is entitled to a position equal in seniority, status and pay to the one he left.

These provisions do not apply to employes of States, but it is the sense of Congress that the States should adopt them and many States have passed laws to effect this.

The Veterans Personnel Division of Selective Service will assist veterans in securing their former positions. Assistance in obtaining new positions is a responsibility of the Director of Selective Service exercised through the U. S. Employment Service of the War Manpower Commission.

Asphalts for Roads and Streets

No limitations are placed on the use of asphalt in 1944, and it may be used by States on any work that is authorized by WPB Order L-41-E (see PUBLIC WORKS for May); and officials are urged by Col. J. Monroe Johnson, director of ODT, to expedite its transportation in cars and trucks; and he suggests speeding up testing processes by (1) stationing of state inspectors at the refineries for on-the-spot testing of asphalt; (2) state acceptance of reports of commercial testing laboratories and certified tests of refineries; and (3) dispatching of samples by express to state laboratories before shipment by tank car or truck.

Bituminous distributors are still scarce, and WPB states that there is little hope that production of them this year will exceed that of 1943.

Charges for Removing Refuse

Charges for ash, debris, garbage or trash removal performed for a municipality or any other government, or where the charges for these services are established or approved by a government body, have been exempted from price ceilings by the Office of Price Administration. The action became effective May 8.

Any services of this nature performed for a private employer, where the rates or charges are not established or approved by a government agency, will remain under price control, OPA pointed out. They will continue under the services regulations, with the highest rate he charged in March 1942 serving as each employer's ceiling.

These services, which are generally performed for a government body, either federal, state or municipal, are vitally connected with health maintenance. The scarcity and rising cost of labor have raised numerous problems in the providing of an adequate supply of such services. Today's action will enable local governing officials to cope promptly with their particular community problems.

Track-Laying Tractors in Demand

Prewar production of track-laying tractors averaged about $45,000,000 a year. In 1942 it was over $55,000,000, in 1943 it was $97,000,000 and is now at the rate of $133,000,000 a year. In spite of this, military demand has increased so greatly that practically no new ones are available for civilian requirements; in fact, many used tractors are being bought by the Defense Supplies Corporation to create a pool from which WPB can fill critical requirements.

Water and Sewerage Conferences This Month

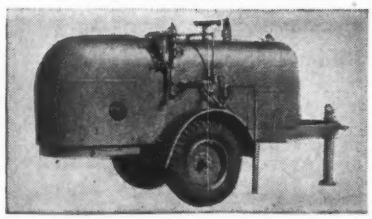
May and June are the big months for waterworks and sewerage conferences. (They used to call them conventions). Last month it was the New England Water Works Assn., Ohio Section of A.W.W.A., Maryland-Delaware Water & Sewerage Assn., and Penn. Water Works Operators Assn.

This month it is the A.W.W.A., Maine Water Utilities Assn., N. Y. State Sewage Works Assn., Ohio Conference on Sewage Treatment, Central States Sewage Works Assn., and Louisiana Conference on Water Supply and Sewerage.

By far the biggest event of them all is the A.W.W.A. Conference at Milwaukee, June 13-16. Tuesday afternoon there will be three meetings, of the Plant Management and Operation Division, the Water Purification Division, and the Water Works Practice Committee. On Wednesday morning there will be a General Session and a meeting of the Water Purification Division. On Wednesday afternoon, a joint session of the Plant Management and Operation and the Finance and Accounting Divisions, and a meeting of the Water Purification Division; and Wednesday evening a public meeting.

On Thursday there will be General Sessions in the morning and afternoon, and also in the afternoon an open session of the Steel Pipe Committee. Friday morning there will be a meeting of the Finance and Accounting Division and an open session on Ground Water Supplies; also a business meeting of the Water and Sewage Works Manufacturers Assn.

Exhibit A...OF A VITAL POSTWAR JOB, EVERY COUNTY, U. S. A.



Cleaver-Brooks Portable Tank Car Heater—a high pressure, oil-fired, compact mobile heater, available in two and three tank car sizes.

Truck-mounted Cleaver-Brooks Portable Pumping Booster used in airport, flight strip, and road construction.

THE above picture could be that of any one of scores of American highways. Temporary patching and spot repairs may serve for the duration, but War's end will call for a nation-wide program of existing road reconstruction plus new highway projects.

Be ready—be competitively equipped—to get your full share of the work.

Time and cost-saving machines will enable you to handle more jobs with more profit . . . Write today for complete information on Cleaver-Brooks Tank Car Heaters and Bituminous Boosters. Get the complete facts on their high speed low cost performance—heating road oils and bituminous materials to application temperatures. Learn why the original and exclusive Cleaver-Brooks four pass down-draft flue travel and integral burner construction, plus the positive dry-coil method of condensate return, provides unsurpassed speed and economy. Cleaver-Brooks Tank Car Heaters are built in two and three tank car sizes—Portable Pumping Boosters in two capacity sizes, with truck mounting or 4-wheel trailer. Send for bulletins or see your Cleaver-Brooks distributor.

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TANK CAR HEATERS . . . BITUMINOUS BOOSTERS . . . AUTOMATIC STEAM PLANTS

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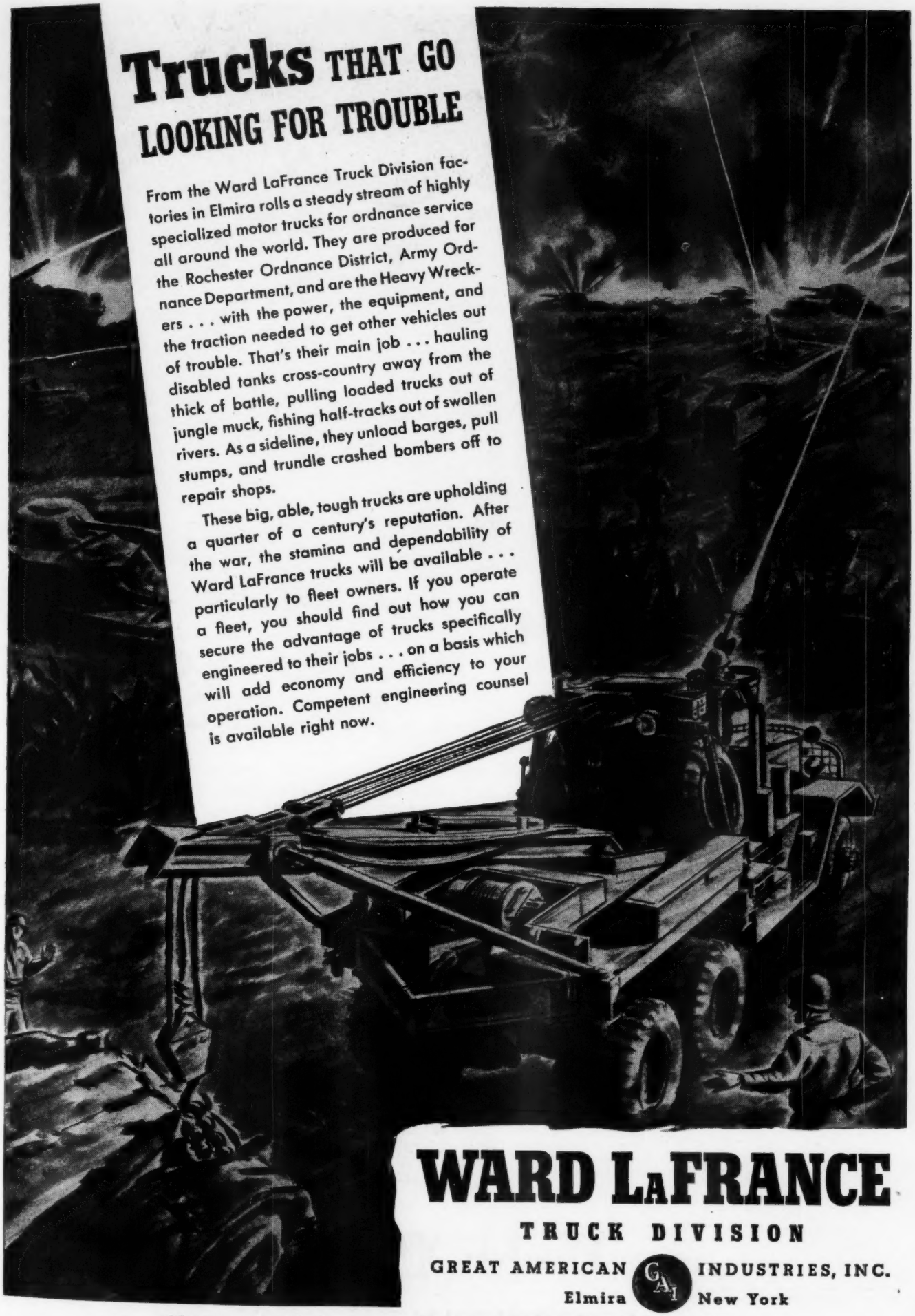

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From the Ward LaFrance Truck Division factories in Elmira rolls a steady stream of highly specialized motor trucks for ordnance service all around the world. They are produced for the Rochester Ordnance District, Army Ordnance Department, and are the Heavy Wreckers . . . with the power, the equipment, and the traction needed to get other vehicles out of trouble. That's their main job . . . hauling disabled tanks cross-country away from the thick of battle, pulling loaded trucks out of jungle muck, fishing half-tracks out of swollen rivers. As a sideline, they unload barges, pull stumps, and trundle crashed bombers off to repair shops.

These big, able, tough trucks are upholding a quarter of a century's reputation. After the war, the stamina and dependability of Ward LaFrance trucks will be available . . . particularly to fleet owners. If you operate a fleet, you should find out how you can secure the advantage of trucks specifically engineered to their jobs . . . on a basis which will add economy and efficiency to your operation. Competent engineering counsel is available right now.

WARD LaFRANCE

TRUCK DIVISION

GREAT AMERICAN INDUSTRIES, INC.

Elmira New York

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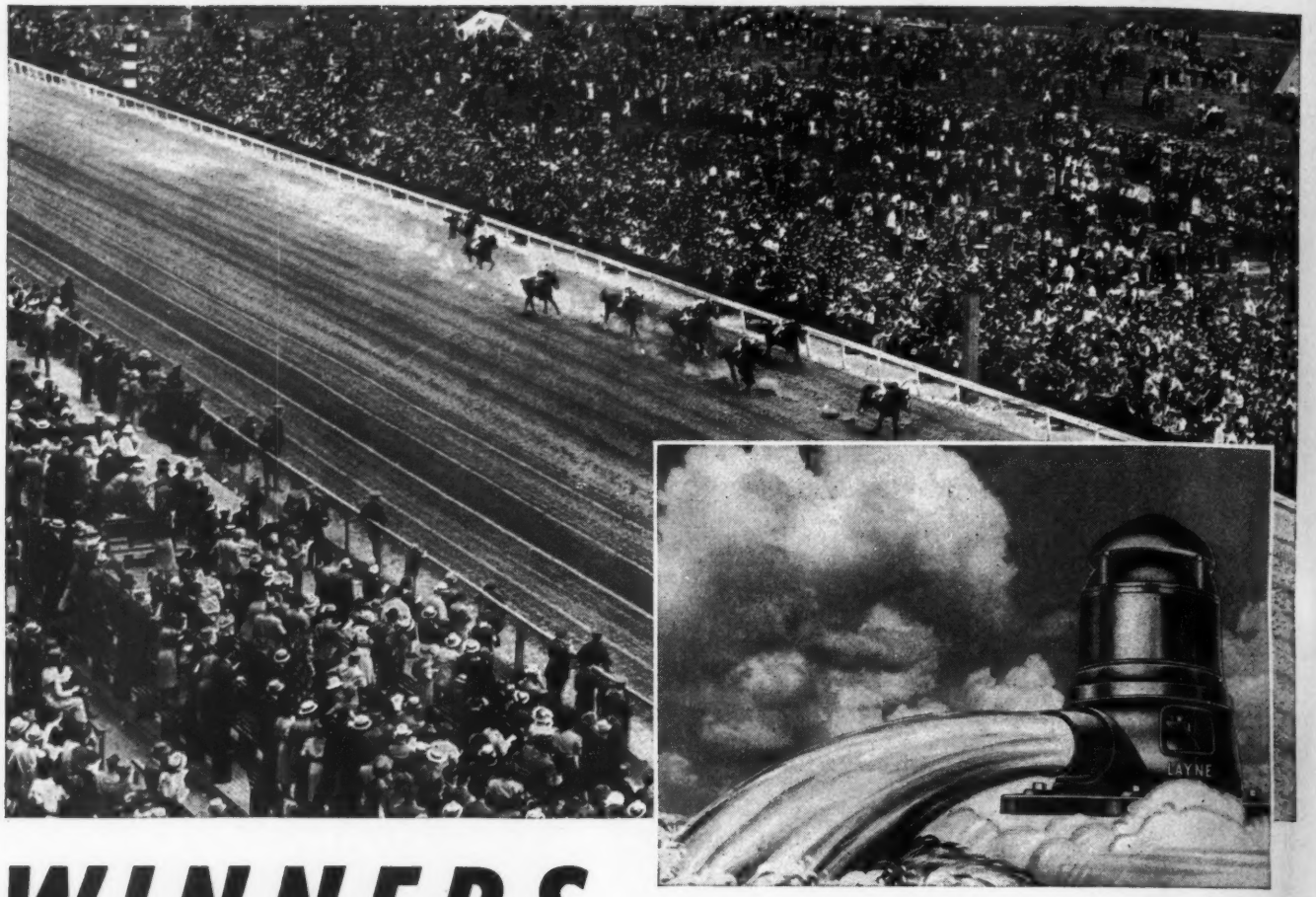

WINNERS MUST HAVE QUALITY . . . AND ENDURANCE

62 YEARS of Water Producing Experience

(LISTED BELOW ARE LAYNE AFFILIATED COMPANIES, ALL OF WHOM ARE FULLY EQUIPPED TO PROVIDE COMPLETE WELL WATER DEVELOPING SERVICE)

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Maybe you didn't have your money on the winner in the 70th Kentucky Derby! Maybe you couldn't pick a horse like Pensive from a field of 16 starters. But one thing you did know—and have always known—is that it takes quality and endurance to win in any race.

In buying your postwar Water System, you had better remember the quality-endurance formula. You can't afford to own an "also ran" water system when the days of war are over and peace is here again.

You can put your money square on the "nose" of a Layne Water System—and always win. You will win on quality and endurance. You will get large quantities of water at low cost. You will get dependable performance year in and year out. And you will get a mighty big reward in knowing that you own the world's finest and most efficient Water System.

Right now is a good time to make preliminary plans. You can secure the aid of Layne Engineers without obligation. You can get set for the days of peace. Late literature will be helpful. Address Layne & Bowler, Inc., General Offices, Memphis 8, Tennessee.

LAYNE

WELL WATER SYSTEMS

DEEP WELL PUMPS

The Only Packaged Joint for Cast-Iron Pipe

AT the left a Dresser workman is packing a box of twenty-four 6″ Dresser Bellmaster Joints. These Joints are completely assembled. They are easy to store, easy to transport to the job site. And ordinary labor requires only two to five minutes to install. Remarkable savings in time, labor and materials are thus made possible.

In many other ways as well, the development by Dresser of this light, strong, flexible mechanical joint marks the greatest advance in cast-iron pipe joining since Simpson invented the idea of caulking joints over 150 years ago.

You are cordially invited to investigate the Dresser Bellmaster Joint for your new lines. Sizes available are 3″, 4″, 6″, 8″, 10″, 12″, and 16″ CIP. Send us your inquiries or write for Catalog 413ARM.

IMPORTANT STYLE 85 ADVANTAGES

1. Factory assembled—shipped, stored and installed in one piece. Compact, easy to handle.
2. Installed by ordinary labor in from two to five minutes—in any weather—above ground or in the ditch.
3. Enclosed by the bell which protects it from electrolysis. No exposed parts to crack, break or corrode.
4. Only tool required—a Bellmaster wrench to tighten capscrews.
5. Uniform and permanent tightness. Expansion, contraction, deflection and vibration safely absorbed.
6. Small working space—no bell holes needed.
7. Holding strength—pull-out prevented by locking lugs.
8. Gaskets suitable for all CIP services. Specify service when ordering.

Working Principle. *A resilient rubber-compound gasket, compressed by capscrews between two malleable rings and against the bell and pipe, effects the flexible, leak-proof seal.*

DRESSER MANUFACTURING COMPANY • BRADFORD, PA.

ONE OF THE DRESSER INDUSTRIES

THOUSANDS TRANSITE PIPE

"Blueprint Now!"

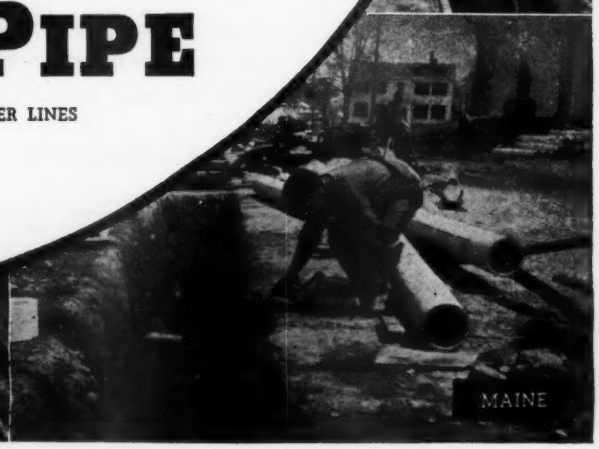
ONE WAY to provide immediate jobs for our fighting men when they return — and at the same time permanently benefit our cities, towns and villages—is through the improvement and expansion of our water and sewerage systems. Such a program, to be effective, must be ready to put into operation as soon as wartime restrictions are lifted.

That means getting the planning done now. As an aid to post-war planners, the Committee on Water and Sewage Works Development has prepared a booklet entitled "Blueprint Now!" If you have not received a copy, one may be obtained by writing the Committee at Suite 2110, 500 Fifth Avenue, New York 18, New York.

When writing, we will appreciate your mentioning **PUBLIC WORKS**

OF MILES OF

... are providing efficient, dependable, economical water transportation throughout the nation



IN THE THOUSANDS OF MILES of Johns-Manville Transite Pipe in service today, you will find installations of almost every size and type. In big cities, small villages, in military camps and bases both here and abroad, Transite Pipe is serving efficiently in the transmission and distribution of water.

There are definite reasons for this wide acceptance. Made of asbestos and cement, Transite Pipe provides these important advantages:

Easy Handling. Light-weight Transite Pipe requires fewer men for handling. Only the larger sizes need mechanical handling equipment.

Tuberculation No Problem. Non-metallic in composition, Transite cannot tuberculate. Its initial high-flow coefficient (C-140) can never be reduced by tuberculation.

Low Maintenance. Made of asbestos-cement, Transite's corrosion-resistance and maintained strength contribute to its low maintenance costs.

Tight, Flexible Joints. Wide sweeps can be made with straight lengths because the Simplex Coupling stays tight even when the line is deflected as much as 5° at each joint.

Rapid Assembly. Even unskilled crews form tight joints easily, quickly with the Simplex Coupling.

For the complete facts, write to Johns-Manville for Transite Pipe Booklet TR-11A. For details on Transite Sewer Pipe for more efficient sewage disposal systems, ask for TR-21A. Johns-Manville, 22 E. 40th St., New York 16, New York.

TRANSITE PIPE IS AGAIN AVAILABLE FOR PROMPT SHIPMENT

JOHNS-MANVILLE

Asbestos

TRANSITE PIPE

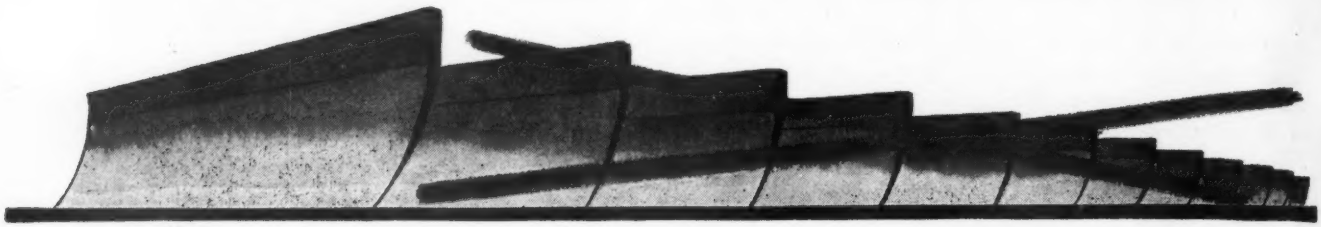
FOR EFFICIENT, ECONOMICAL WATER AND SEWER LINES

JOHNS-MANVILLE JM PRODUCTS

When you need special information—consult the classified READER'S SERVICE DEPT., pages 96-99

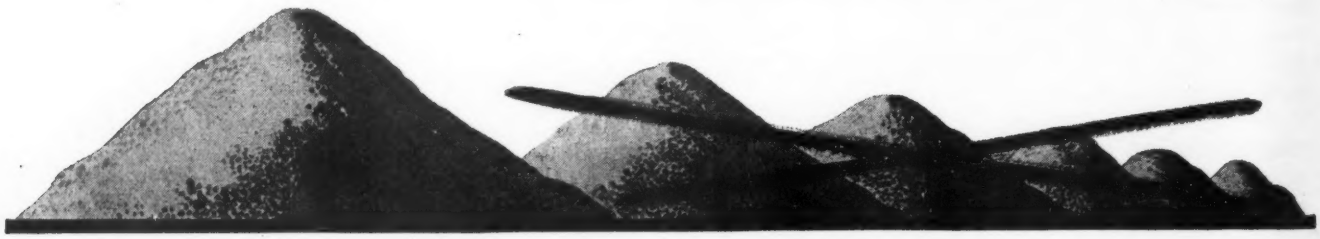
SAVES MANPOWER

All the way down the line, less manpower is needed when gravel-type roads are maintained with calcium chloride, since hauling and placing of resurfacing materials is eliminated and much less maintenance is required.



CUTS BLADING

Each maintenance blader can serve ten times as many miles when roads are consolidated with calcium chloride. Thus the life of hard-to-get cutting edges is lengthened tremendously and blading equipment is conserved.



CONSERVES ROAD MATERIALS

In preventing loss of road materials through traffic action and dust, calcium chloride maintenance saves up to 300 cubic yards of aggregate per mile annually. This also results in saving of tools, shovels, trucks and tires.

In addition to the cost and labor saving advantages of calcium chloride use, the elimination of dust and compaction of road surfaces serves the war effort by protecting the health and safety of essential farm and industrial workers. Mail coupon for a 62-page Bulletin, "Surface Consolidation and Maintenance."

CALCIUM CHLORIDE ASSOCIATION, 4145 Penobscot Building, Detroit, Mich.

CALCIUM CHLORIDE
for SURFACE CONSOLIDATION

CALCIUM CHLORIDE ASSOCIATION
4145 Penobscot Building, Detroit, Mich.

Please send new 62-page Bulletin on "Surface Consolidation and Maintenance."

Name_____

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AN OPEN LETTER

TO THE NATION'S ROAD BUILDERS

HUBER is pleased to announce plans have been perfected to build a complete line of modern road machinery the moment the war ends. The line will include: Three-wheel Type Road Rollers from 5 to 12 tons; Tandem Rollers from 3½ to 12 tons; Maintainer, Bulldozer, Speed Scoop, Sweeper, Mower and Snow Plow.

To make sure the plans were right, a thorough research into the postwar future of road building and maintenance was made. To these findings were added HUBER'S seasoned knowledge of Road Builder's needs plus its years of experience in building dependable road machinery. With such a background to draw upon, the new HUBER Line becomes an outstanding contribution to the road building industry and the greatest achievement in HUBER'S history.

To insure manufacturing excellence in building this new HUBER Line, thousands of dollars have been invested in the latest of machine tools and production methods. HUBER is proud of its new Road Machinery for it measures up in every way to the big demands that will be made on it when the postwar road building activities start. Distributors interested in the new HUBER Line are urged to write us. Some choice territories are still available.

Don Howard

President.

THE HUBER MFG. COMPANY · MARION, OHIO, U.S.A.

3 WHEEL ROLLERS · TANDEM ROLLERS
MAINTAINERS · BULLDOZERS
SPEED-SCOOPS · SWEEPERS
HIGHWAY MOWERS · SNOW PLOWS

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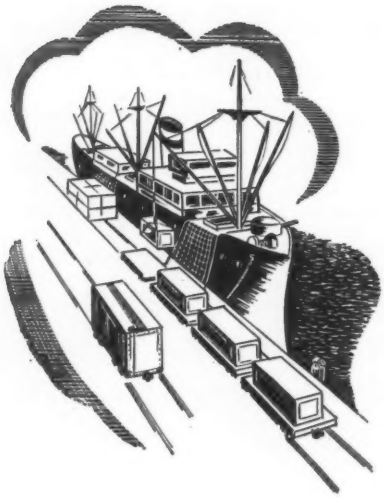
13 GRAVER ROTARY DISTRIBUTORS

TO SERVE THE U. S. ARMY ABROAD



● Thirteen Graver Rotary Distributors complete with all accessories have been sent overseas . . . ready to be installed by Army engineers to assist in affording vital protection to the health and safety of our fighting men.

These thirteen rotary distributors were designed and built by Graver . . . completed to exact Army specifications . . . built to render efficient service under the most difficult conditions, and they will undoubtedly remain intact to continue serving Americans and their Allies long after the war.

This sizable order from the U. S. Army is particularly indicative of Graver's ability to design and build sewage treatment equipment . . . it shows that Graver equipment is enjoying wide acceptance wherever and whenever sewage treatment plants are required.

On the home front Graver Sewage Treatment Equipment is also playing an important role . . . serving Army cantonments and municipalities in all sections of the country . . . rendering effective and low-cost treatment . . . helping protect the health of fighting men and civilians, alike.

If you are planning to enlarge the capacity of your present plant, or install complete new plants, Graver engineers can help you. Call upon them—they will be glad to submit designs and cost estimates without the slightest obligation on your part.

GRAVER
SEWAGE TREATMENT EQUIPMENT

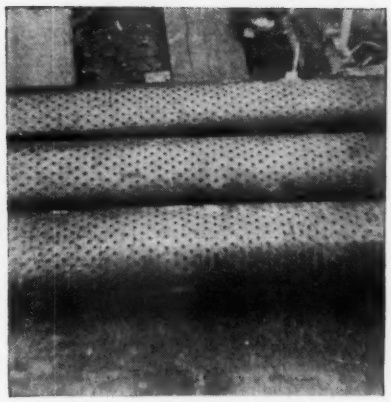
Process Equipment Division
of
GRAVER TANK & MFG. CO., INC.
4809-39 Tod Ave., East Chicago, Ind.
NEW YORK CATASAUQUA, PA. CHICAGO TULSA

PUBLIC WORKS Magazine . . . JUNE, 1944

Vol. 75. No. 6

Old 12" screen removed from 30" well.

Screen and casing removed from 20" well.



New 12" screen installed in 30" well.

Rehabilitating a Gravel Well

How a corroded 12" screen was removed from a depth of 178 feet and replaced with a new 12" screen and a new casing, increasing the delivery fifty percent.

By A. A. ULRICH

Manager, Massillon Division, Ohio Water Service Co.

MASSILLON is a city of 30,000 population, located in the highly industrial section of northeastern Ohio, in Stark county. The water supply for the city is owned and operated by Ohio Water Service Company. Being located in the Tuscarawas river valley, Massillon is favorably situated for its water supply. The old buried valley over which the present Tuscarawas river flows provides an abundance of ground water. Stark county has several glacial deposits, the youngest being that deposited by the Wisconsin glacier. The old buried valleys represent former drainage channels, which existed previous to glaciation, at much lower levels than the present valleys, and which, subsequent to the action of glaciation, became filled with sand, gravel and clay. This material, highly favorable for acting as large ground-water reservoirs, received its original supply from a concentrated mass of melt water pouring from the ice front of the glacier. Rains which fall in this area are rapidly absorbed to maintain the permanent water table.

Potable ground water derived from bed rock is also found in Stark county, particularly in the western part of the county in rock known as Massillon sandstone, averaging 40 feet in thickness. This productive sandstone generally supplies the normal demands of the farmer and domestic consumers. The Massillon sandstone is commonly referred to as the "Big Injun" sand by the well drillers.

The public water supply for Massillon is taken from twelve 6" sand-rock wells averaging 150 feet in depth, producing 1 m.g.d.; and two gravel wells, one 178 feet deep, drilled in 1919 with a tested capacity of 3 m.g.d., and the other 158 feet deep, drilled in 1924 with a tested capacity of 4 m.g.d. The well supply is augmented by an auxiliary surface supply from Newman creek. The water from both sources is treated and softened in a modern and complete lime-soda ash softening plant.

Although most water departments are running at peak capacity and many communities find it necessary to restrict and conserve the use of water, Massillon has never had to restrict the use of water to its consumers. However, in order to meet the increased demand during this war emergency, we found it necessary to rehabilitate one of the gravel wells. During the past ten years this well dropped off in capacity from 3 m.g.d. to 1.4 m.g.d. The records of this well showed an increase in the draw-down as the capacity dropped off; however, the static level of the

A. A. Ulrich

well remained the same, but where it was originally attained in two minutes it now required 15 minutes. This was a substantial indication that the trouble was not in the groundwater supply but was due to a clogged screen or to corrosive elements and fine sand and silt packing in the gravel around the screen, so as to retard the flow of water to and through the well screen.

When this condition was first noted in 1933, we swabbed and bailed the well, which improved the flow but only for about a year. In 1935 we decided to use acid to clean the screen; however, because of the age of the original 12-inch screen, 80 feet of new 10-inch screen was first inserted inside the old screen, to prevent the old from collapsing. The application of muriatic acid increased the flow from 2.2 to 2.7 m.g.d., which held up for one year but again started dropping off. During the next seven years, we treated with acid three times and dry ice once, but with very little effect. Since little improvement resulted from additional acid treatment and since there was added danger of deterioration from the acid action on the screen, it was decided to remove the old 12-inch screen, now 24 years old, and the 10-inch screen installed in 1935 and replace them with new 12-inch screen. We realized that this work might prove very difficult, with the danger of losing the well entirely if the gravel should settle and the entire well and well house should collapse. The work was planned for the winter, the off-peak season, when the well could more easily be out of service.

The work was started on December 15, 1942, by inserting an 8-inch pipe into the well and sanding this pipe into the 10-inch screen, after which the 8-inch pipe would be pulled and remove the 10-inch screen sanded tight to it. We hoped that the old 12-inch screen would be attached to the 10-inch by mineral deposit and incrustation and would also be removed, in whole or part, with the 10-inch screen.

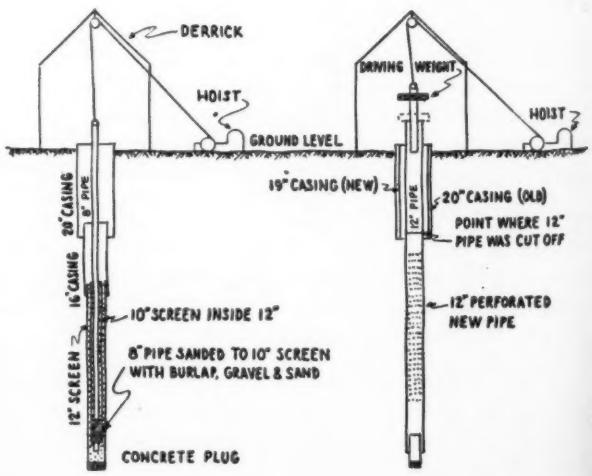
The original well had been constructed with a 20-inch copper-covered spiral screen which extends down 66 feet and overlaps a 16-inch blank pipe extending down 37′-6″, which in turn overlaps the 12-inch screen, which extended down 84 feet to the bottom of the well.

The 8-inch pipe was extended down 153 feet, at which depth the bottom 10 feet was sanded tight into the 10-inch screen. This sanding was accomplished by wrapping burlap sacks around the 8″ pipe at the bottom of the first section of pipe inserted into the 10″ screen, as shown in the drawing, enough sacks being used to fill in the space between the 8″ pipe and 10″ screen. After lowering the pipe to the bottom of the 10″ screen, gravel was poured into the space between the two to a depth of about 2 feet above the burlap. Sand was then poured on top of the gravel to a depth of about 8 feet. The gravel and sand, held in place by the burlap sacks, formed a tight wedge between the pipe and screen, which became more secure as the 8″ pipe was pulled from the well. By hanging sheaves from a derrick over the well, a steel cable was extended from the top of the 8 inch pipe, through the sheaves, to a gasoline-operated hoist. A series of sheaves were used to increase the pulling power of the hoist, since the hoist alone could not pull the screen. Two 70-ton jacks were used, in addition to the hoist, but even so the procedure was very slow, only about eight or ten feet being pulled each day. The first to appear was 62 ft. of the 10-inch screen, and with it came 22 ft. of the old 12-inch and all of the 16-inch blank casing. One length, or 18 feet, of 10-inch screen and 62 feet of old 12-inch screen still remained in the well; having been cemented into the plug at the bottom of the well, they pulled apart from the upper sections as they were pulled from the well. These could not be removed, because the well filled in with sand and gravel to a point 66 feet from the top of the well, which was the bottom of the 20-inch spiral screen.

After removing the old screen, it was decided to place 19-inch casing inside the old 20-inch casing for the top 66 feet of the well. The use of 19-inch pipe allowed sufficient clearance for the bowls of our deep-well pump, which are 17 inches in diameter. From the bottom of the 19-inch casing, would be extended 110 feet of 12-inch pipe, of which the bottom 85 feet was to be perforated with ⅜-inch holes on 1½-inch centers; the two sizes of pipe to overlap about 5 feet, which would make the total depth about 171 feet.

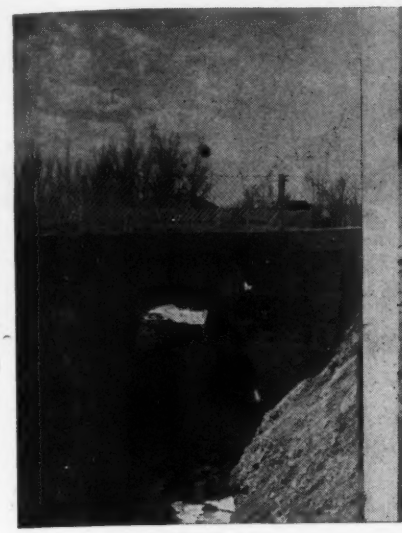
Sinking of the 12-inch was started by bailing from the inside, but upon reaching a depth of 99 feet from the top of the well, it was necessary to start driving it. The process of driving, by the use of the hoist and cable to which was attached a heavy weight, was very slow and required an entire month. Some days we were able to drive the pipe only a few inches. The pipe would be driven about 5 feet and then the sand and clay bailed out. When we reached the section of 10-inch screen at the bottom of well, the 12-inch had to cut down through the old 10 and 12-inch screens, as it was being driven. Pieces of these screens were removed by the bailer as the new 12-inch screen was installed. At the end of a month of driving, the

(Continued on page 80)



At left: Sketch showing how 8″ steel pipe was extended down into 10″ screen and sanded fast to pull the 10″ screen; 12″ screen and 16″ casing. The 8″ pipe was wrapped with burlap sacks to fill space between 8″ and 10″, about 3 ft. of gravel was poured in between the 8″ and 10″ pipe, followed by 7 ft. of sand.

At right: Showing how 12″ perforated pipe was driven by dropping heavy weight. After driving the pipe 5 ft. the weight would be removed and a bailer used to bail out the sand and gravel from inside the 12″ pipe.



Outlet end of culvert.

Inlet end of culvert.

Lowering the pipe into place.

Making Culverts from Penstock Pipes

By Oren L. King, Assoc. M. Am. Soc. C E
City Manager, Montrose, Colorado

Because of war priorities, two fifty-foot culverts were made with 7.5-foot steel pipes used as penstocks by a nearby abandoned power plant.

Running through the city of Montrose, Colo., is a small stream called the Arroyo which drains not only part of the city but also a considerable area of the adjacent territory. This stream flows through thirteen culverts and wooden bridges throughout the city, some of which are of inadequate capacity at high-water periods.

During the past year we replaced one of the culverts and one of the wooden bridges with pipe 7½ ft. in diameter, made of ⅜-inch steel, well riveted, braced and coated, which formerly had been used by a nearby abandoned power plant as penstocks from the canal to its turbines. These pipes were in excellent condition, and cost us about $300 for each of the two 50-ft. culverts.

These pipes were placed in the bed of the Arroyo with an impervious cut-off wall at each end, which extended down to solid shale foundation two to five feet below the invert, and were carried up to the grade of the street, or a height of about 15 ft. These were about 50 ft. apart and thus gave practically the entire width of the street for traffic, and were capped with concrete sidewalks protected by wire netting railings.

The equipment used in constructing these culverts consisted of two P&H. draglines, one of them ¾ yd., the other 1½ yd. capacity, one owned by the city, the other rented for a day at each installation; the only other equipment being a 5-S concrete mixer, the city grader and small tools.

In making these improvements we were restricted in choice of materials by war priorities, but believe that the culverts built are as permanent as could be

(Continued on page 31)

Site before constructing the culvert and afterward.

Author Oren L. King.

Part of 4,000 rats caught at a poorly operated dump.

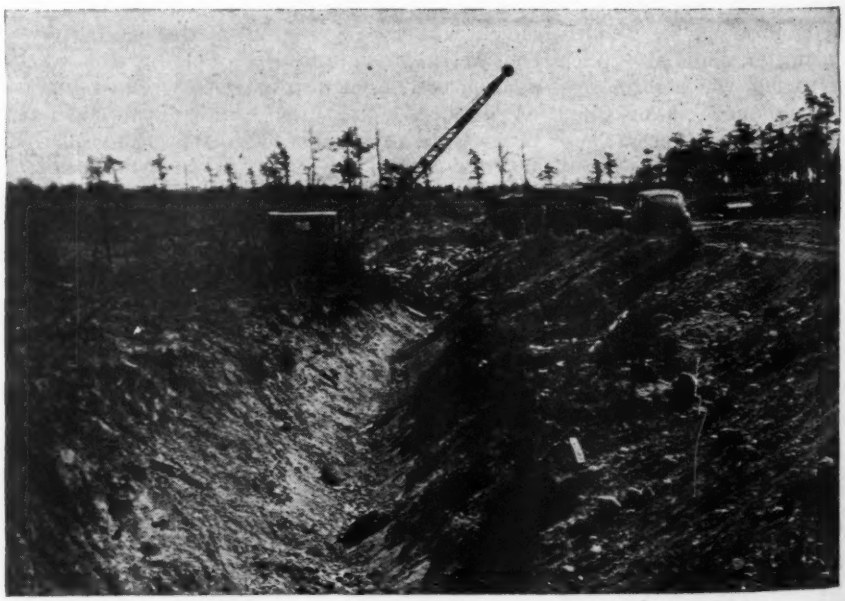
Sanitary Engineering Se

By ROBERT N. CLARK
Lt. Col., San. C.

CONTRARY to certain popular opinion, the administration and discipline of the United States Army does not consist entirely of issuance of orders by higher authority and blind adherence to such orders by all lower echelons. It is true that rigid discipline is necessary and is observed in certain situations, but to the greatest possible degree the Army relies on the initiative and energy of each individual to advance his phase of Army activity. Since this is so, there is bound to be a variation in aims and procedures among different commands, and the policies in effect in the First Service Command may not exist in other regions where personalities and conditions are considerably different.

Essentially, however, Army sanitation in all of its phases is governed by Army Regulations, which define the scope of sanitary supervision to be exercised by the Medical Department, of which the Sanitary Corps is a part, and basically all sanitary engineering service derives its duties and authority from this source. The Medical Department is charged with the duty of "investigating the sanitary condition of the Army and making recommendations in relation thereto," and Sanitary Corps sanitary engineers are assigned to "Sanitary engineering problems relating to water supply and treatment, sewage treatment and disposal, mosquito control, rodent and insect control, general sanitation problems, camp site surveys and the instruction of officers and enlisted men in field sanitation methods." Although Sanitary Corps duties are restricted to investigation and recommendation, an officer's value is dependent on his ability to accomplish results, so the function of "promoting" a project through preliminary and final stages is a necessary addition to his prescribed duties. In practice the design and construction of sanitary engineering works is accomplished by the Corps of Engineers, subject to approval by the Medical Dept.

The first sanitary engineer reported for duty in the First Corps Area (later the First Service Command) during March 1941. Construction activities and the expansion of the Army were proceeding at an accelerating rate, and the demands for sanitary engineering service were overwhelming. During the summer of 1941 two or three additional sanitary engineers and a like number of officers with public health training but no engineering experience were assigned to duty. All of these were Reserve Officers, called up for a year of active duty training. Work was restricted to water supply, sewage disposal, and mosquito control, and other projects were taken up only under urgent pressure. Following the declaration of war, the rate of procurement of qualified officers was stepped up, and more help was available; but the rapid establishment of coastal defense positions, training camps and service installations, each with its own critical sanitation problems, resulted in a continuing shortage of Sanitary Corps officers. It was manifestly impossible to assign a trained engineer to each project, and it became a serious administrative problem to



Ditch for sanitary fill. Trucks at the right are dumping garbage into the ditch.

ring Services in the First Service Command

Duties of the Sanitary Corps include investigations and recommendations relative to water supply and sewerage, to mosquito, rodent and insect control, and general sanitation of the Army camps.

Group of Sanitary Corps officers at a conference held in October 1943.

***Front Row*, Left to Right: Lt. Col. J. J. Gilbert; Lt. R. R. Hilton; Lt. R. F. Wagner; Maj. L. E. West; Capt. P. E. Johnson; Capt. Alex Black; Lt. Col. R. N. Clark; Lt. A. E. Williamson; Lt. S. E. Wedberg; Lt. G. J. Coogan; Lt. R. H. Albrecht; Lt. R. J. Cantrell; Capt. R. A. Hagberg. *Second Row:* Capt. A. J. Houghton; Capt. R. G. McCall; Lt. A. E. Sparr; Lt. R. S. Fraser; Capt. S. J. Silverman; Capt. R. H. Wharton; Lt. A. J. Singer; Lt. C. E. Potts; Lt. Col. Chester Cohen; Capt. A. D. Swisher; Lt. Donald DeLeon; Lt. Col. M. J. Mackler. *Third Row:* Lt. A. J. Dyer; Lt. K. G. Barnhill; Capt. V. M. Hynes; Lt. A. W. Clarkson; Lt. G. W. Comita; Lt. R. F. Greeley; Lt. J. B. C. Muddiman; Lt. H. H. Fick; Capt. A. A. Thomas; Maj. E. J. Staff; Lt. E. F. Ward.**

provide proper supervision for the numerous scattered installations. During 1942, sanitary engineers were assigned to certain key stations, and temporary duty orders were issued from headquarters for the individual engineers to proceed to other points as needed. Early in 1943 a plan was set up permitting engineers, known as Post Sanitary Officers, to inspect installations within a prescribed area on their own initiative, and following a semblance of stabilization in the military program it has been possible to establish complete routine coverage of all installations. During the first two years of activity the sanitation program might have suffered greatly had it not been for the intelligent and wholehearted cooperation of the Corps of Engineers and the six state health departments of New England. Many potentially serious situations were met by prompt and effective action on the part of some individual who had no legal obligation to act. At the present time there is available an adequate force of sanitary engineers in the First Service Command, organized to care for the needs of the Army in New England.

Control of Water Supplies

The sanitary control of water supplies is one of the basic functions of the Sanitary Corps. Although all plans for new supplies are subject to review by a sanitary engineer, considerable stress is laid upon field inspection before and during construction, it having been found that under the Army program the most direct and effective action can be taken in the field. In many cases, time limitations do not permit the completion of detailed plans prior to the start of construction, and a well-ordered routine of design, review, and revision of plans is a practical impossibility. It has been found that there is less red tape to unravel when the inspecting officer makes a direct verbal recommendation to the construction officer, and permits the latter to initiate the proper correction. If it is apparent that such action is not being taken, the inspecting officer can still take official steps and accomplish the desired

results. It might be objected that informal verbal action does not give on-the-record credit to the sanitary engineer. This may be so, but the objective of every man is to get the job done, and done right, and let the Army get the credit. As a matter of fact, the submergence of desire for immediate prestige has enhanced the reputation and increased the effectiveness of individual officers.

Completed water supply installations are inspected by a sanitary engineer, and his initial report becomes the basic Medical Department record. The frequency of routine field inspections is left to the discretion of the engineer on the ground, but a complete re-inspection and report is desired annually. Where Army establishments secure water from public supplies, the complete systems are inspected in company with interested civilian officials. Water samples are collected periodically either by the Post Sanitary Officer or by a medical officer, and submitted to the First Service Command Laboratory. In addition, the results of inspection and sampling of public water supplies by public health agencies are examined as occasion may arise. Supervision of water treatment, particularly chlorination, is another duty of the Post Sanitary Officers. Here, as in almost every other phase of their work, the Sanitary Corps officers must maintain close cooperation with the Post Engineers who are responsible for operation of all utilities. Actually, the Post Sanitary Officer is responsible only for general supervision of water treatment; but in many instances he has specialized knowledge of equipment and methods which make it desirable for him to take an active part in the operation of a plant. The main idea is to get the job done in the best way possible.

The Army standards of water quality are about the same as those currently in use in the water-works field, except for the requirement of a higher chlorine residual. To meet the prescribed standard it has been necessary to rechlorinate some previously treated water supplies where the service lines enter military installations. There have been cases where local water officials considered such practice a reflection on the quality of their supplies, and other cases of amused tolerance at the fussy insistence of the Army on this point; but whatever the surface attitude, there is evident a deep-seated desire on the part of all water-works officials to aid the war effort and to cooperate with the Army to the fullest extent.

Sewage Disposal

The problems in connection with sewage treatment and disposal are closely tied into the welfare of civilian areas, and the design and operation of such works is based upon the elimination of conditions detrimental not only to the Army but to the public health as well. Consequently the Post Sanitary Officer must keep himself informed as to location of shellfish areas, natural bathing places, public and private water supplies and similar situations which may be affected by sewage contamination. Where joint action is necessary by civil and military authorities, the transaction is ordinarily handled between the State and the Service Command. Where the problem is related solely to the Army it is the sanitary officer's duty to see that no conditions arise which are hazardous to the health of troops, such as the flooding and overflow of cess pools, tile fields or similar works, with consequent exposure of sewage. This entails supervision of sewer systems and sewage treatment works to make sure that no stoppages or interruptions of treatment are likely to occur.

The problems encountered are varied, and may involve several agencies. For example, the operation of grease traps is necessary to prevent congealed grease from stopping up sewers. The installation and repair of grease traps is a function of the Post Engineer; the cleaning of traps is the duty of the mess organization; the collection and disposal of grease is the concern of the salvage officer; and routine inspection is up to the Medical Inspector. All of these are directly concerned and directly aid the program.

Mosquito and Vermin Control

Mosquito control was more or less a new venture in the First Service Command, the last previous work carried out by the Army having been done at Fort Devens at the time of the last war. Because of the urgency of getting control started early in the season of 1941 and because the Constructing Quartermaster forces were overburdened with the emergency construction of barracks and other necessary work, funds were allotted directly to the Medical Department with instructions to hire the necessary labor and purchase materials to institute an effective control program. Through assistance of several of the interested State agencies, surveys were made at the principal Army installations and the program was started in May 1941. This proved to be early enough in the season to result in good control. Although the principal object of mosquito control is to eliminate disease vectors, principally Anopheles quadrimaculatus, control measures were chosen which would be equally effective against most of the pest species of New England. In 1942 the services of an Army entomologist were available and control work was extended with the continuing expansion of the Army. During that year the policy was established, which is still in effect, that all mosquito control work be accomplished by the Corps of Engineers on the recommendation of the Medical Department. An unusual responsibility of the Sanitary Corps in the mosquito control program is that sanitary officers maintain technical supervision over the actual control measures. In most matters the Sanitary Corps makes recommendations only and technical supervision is the responsibility of the Corps of Engineers.

Since the very beginning of mosquito control in the First Service Command, the need has been recognized of coordinating Army work with that of civilian agencies, and wherever possible the programs have dovetailed to insure adequate control in all areas surrounding military establishments. At the present time each Post Sanitary Officer is responsible for mosquito control in his area and expert advice and assistance is available through the Service Command's entomologist.

The problem of vermin control, including rodents, bed bugs, lice and roaches, was left to the individual units until 1943. At that time the rate of expansion had stabilized and sufficient sanitary engineering service was available to permit a definite program of vermin control. Schools were started for the training of Medical Department enlisted men and civilian employees of the Corps of Engineers in fumigation, dusting, spraying and other control measures. Through the excellent cooperation of certain pest control operators in Boston, it was possible to put enlisted men to work with the commercial crews, giving them in a short time a range of experience which might not be available on an Army post over a long period. Following such training, the men were re-

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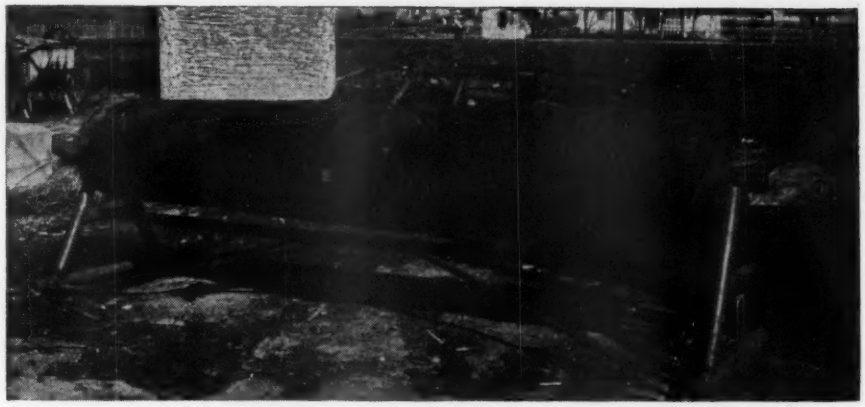

Jig used for welding old blades together.

New Scraper Blades from Old by Welding

Describes in detail the method used in welding four worn-out 8-foot blades to make one 16-foot one. Hundreds of old blades bought from various sources for this purpose.

By **GUY HALL**, County Engineer, McPherson County, Kansas

SINCE about eight years ago we have been reclaiming the used cutting edges or blades of our motor patrols by welding them together, thus giving us a new blade and at the same time using all the steel instead of losing half of it or more. I had heard that this could be done, so tried it with our acetylene torch but did not find this satisfactory so, after some more investigation, we bought a 300-amp Hobart electric welding outfit. This welder is mounted on a trailer and has a gas engine direct connected, so that we can move it to any place in the county and use it on bridge work or for any other purpose we like away from the shop. At the shop we use electric power, as we get that at a very low rate here.

For a few years I bought used eight-foot sections of cutting edges from different sources, having bought something like 1500 pieces in one year, as I did not know when they might not be available and they would not spoil. At that time the stigma of hoarding had not appeared on the scene and building up a stock was considered legitimate. We paid thirty cents each for the worn pieces, which was considerably above junk prices and was attractive to the seller and it gave me the four pieces for a new blade for $1.20. At the time we were able to do the welding for about sixteen cents per foot, or a total of $3.76 for a new sixteen foot cutting edge. Since that time material and labor have advanced considerably and we have only our own blades to reclaim. We have not figured any costs lately, but at thirty cents per foot we still get a new blade for $4.80 against $17.60 for a new one, and we do not have to ask anyone for permission to get them. I might add that we have had no trouble getting welding rod for this purpose. Since the war began my sources of supply were shut off, which is the reason we only have our own worn blades to reclaim.

Guy Hall

The method is as follows. A jig shown in the snapshot was rigged up, using a 16-inch casing for the barrel, mounted on an axle and supported by the frame shown. This casing should be larger, if possible, as it does not conform to the curvature of the blade, but this we took care of by bolting pieces of strap iron under each side of the blade. The two pieces of an eight foot section are butted with the worn edges adjacent. Pieces of proper width are selected and bolted to the casing at the ends. The other small holes seen were provided for using a bar to line up the outside edges when the blade is bolted at the third points, the large holes allowing the hand to be inserted for inserting the bolts.

Frequently the worn edges are not straight, which leaves a space too wide to make it economical to fill it with welding rod, and pieces of scrap steel rods are used to fill as much as possible of this space, the remainder being filled with welding rod. After this is finished, the blade is taken off the jig and the face gone over with the rod so as to leave as smooth a surface as possible.

Of course both pieces of the blade contain bolt holes, but pieces are cut off sucker rods or scrap material to fill the holes on the lower side and covered with welding rod; the other holes being left open to bolt to the moldboard. If the lower holes are not filled, they will cause trouble when the blade is worn back to them.

So far, so good; but the important thing in the process is what might be called annealing. When the blade is taken off the jig after being welded it has warped out of shape enough that it would not fit the moldboard and certain strains seem to have been introduced that make the blade very brittle. In fact, one of the first blades we welded was dropped on the

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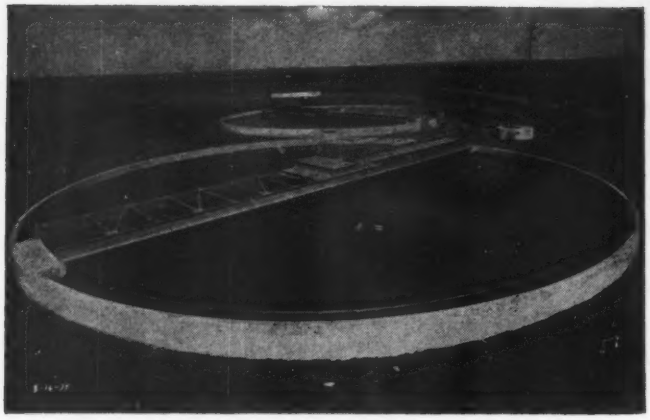


Two 70' Hardinge clarifiers with skimmers at Lincoln, Neb. treatment plant.

Conservation and Salvage of E

By ALDEN E. STILSON
Lt. Colonel, Sn. C., Chief, Sanitary Branch

FOR many years the U. S. Army has studied and practiced edible grease conservation and salvage. There are numerous reasons why the military authorities wish to avoid a national grease shortage. A recapitulation of a few major uses of edible greases in war may be of interest: (1) A soldier's diet requires 4 oz. of fats per day; (2) One pound of grease is needed for each 150 rounds of rifle ammunition; (3) Enormous quantities of fats are needed for high-explosive shells and bombs; (4) A soldier's life depends on grease for camouflage paint; (5) Grease tallow is a prime ingredient of synthetic rubber; (6) Gas mask manufacture demands grease; (7) There would be very little soap without fats; (8) Medicines require many grease derivatives; (9) Leather equipment would soon fail without grease; (10) Grease is necessary for wool uniforms.

Salvaged grease is a great aid, but unsalvaged grease can be a dangerous hindrance to a nation at war in ways suggested by a few examples; (1) Non-controlled grease accumulations are food for disease-carrying insects, flies and rodents; (2) Ground upon which grease has been spilled is unfit for habitation; (3) Fats and greases clog plumbing, sewerage systems, cesspools and septic tanks and impedes sewage treatment; (4) Grease can ruin a precious water supply; (5) Odors from decaying grease or fats will make valuable property untenantable; (6) The manpower and critical materials required to correct, repair, replace and build for the purpose of counteracting damages that accrue from the careless waste and dumping of grease are a serious loss to the war effort.

Long before the war, the Army instigated segregation of all kitchen waste for salvage. This practice protected the health of the command and at the same time saved the tax payers money. The use of grease traps in the Army dates back many years. Training Manuals have emphasized salvage of edible garbage and grease. The soldiers bible, "Army Regulations," imposes direct responsibility on mess officers and all concerned to salvage grease, fats and valuable food. At the School of Bakers and Cooks, the Army teaches kitchen personnel to conserve and salvage grease.

When the storm of war struck, it simultaneously increased the needs for grease at least 250% and at the same time cut us off from the principal sources of palm and cocoanut oils. Faced with a soap and grease shortage, the civilian public has rallied manfully and with ever increasing energy. At the same time, the Army quietly went to work on efforts to increase its savings of this munition.

For example: in the Fifth Service Command it is

Infilco hydraulic skimmer for removing grease.

likely that no further shortening will be issued. For some time back most of the large posts and camps have been experimenting along this line with success. Each soldier's food still contains the prescribed fat it always had. This contribution to the Nation's grease savings has been accomplished through the cooperation of mess personnel, nutrition officers and quartermaster Corps.

Under the direction of the Commanding General and the respective post commanders of the Fifth Service Command, an intensive effort to further increase the amount of grease salvaged is being made. In this plan the post surgeon, engineer, salvage and mess officers collaborate to insure that the least possible amount escapes to the garbage can or the sewer. This plan was first tried out at one large camp with excellent results. In the short time elapsed since the plan has been in operation, favorable results have been noted as follows:

Grease received from traps has been increased from 2.5 lbs per capita per month to about 5.25 lbs. Cooked grease salvaged at kitchens rose from .54 lb to .75 lb per capita per month, while raw meat trimmings and bones increased from .6 lb to 2.4 lbs per capita per month. It should be noted that these weights were based on actual scale weights and not on guess work.

As soon as the National Selective Service act made it certain that new camps would be required, careful consideration was given to the building of devices to recapture grease from the sewage, both at the kitchen and at the sewage treatment plant. The foresight exercised then and since the war commenced has resulted in valuable savings in grease, as well as in costs of construction of utilities, and their operation.

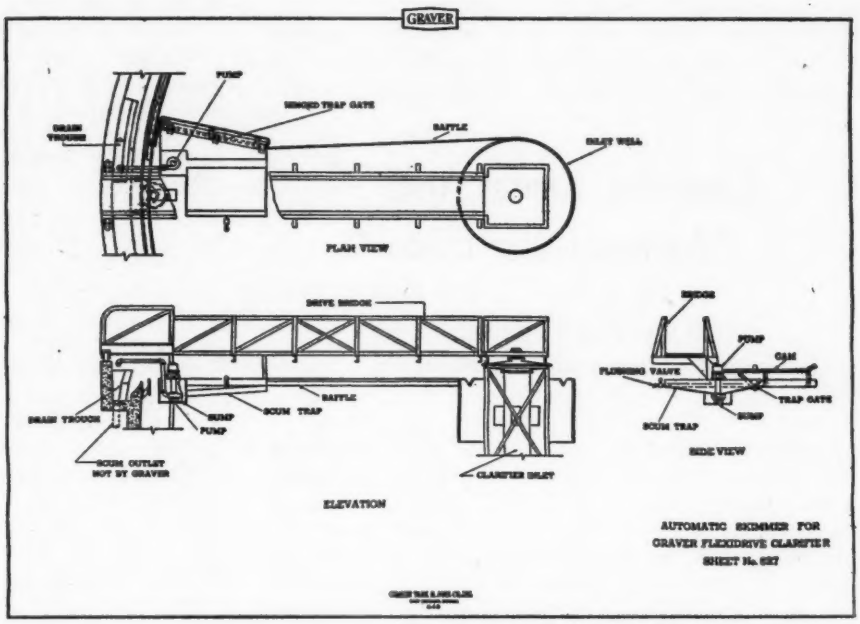
Figures for grease content of city sewage are not available for comparison with Army sewage. However, through the courtesy of F. H. Waring, Department of Health, State of Ohio, certain figures are available which may be of interest. In 1941 the City of Cleveland Easterly Plant determined the average grease in the sewage as being 85 ppm, and Mr. War-

vage of Edible Grease in Fifth Service Command, U. S. Army

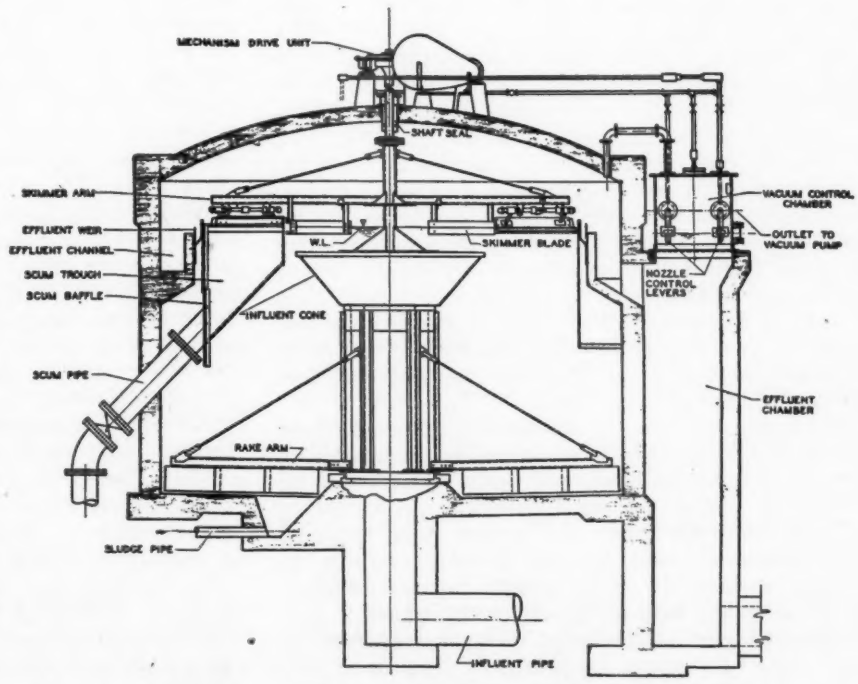
Grease recovered from grease traps and sewage more than doubled since plan was put in operation. While civilian waste of grease into sewer is 60% of what he receives for food, that at army camps is only 25%.

ing believes that the sawage of the City of Columbus may contain about 93 ppm as an average, or .07 lb. per capita in a flow of about 90 g.p.c.d.

The Army sewage treatment plants in the Fifth Service Command have been in operation such a short time that accurate figures over a period of months are not yet available. Such figures as are emerging from the large posts indicate that an approximate figure of 110.8 ppm of ether-soluble grease in the sewage may be close to the truth throughout the area. At one post the average for the 12 months of 1943 was 108 ppm. At first glance this comparison would seem unfavorable to the Army. Possibly the year 1944 will confirm the first impression. On the other hand, there are factors contributing to the belief that the Army has achieved fairly good results. The factors referred to may be outlined as follows: (1) Army sewerage lines are new and reasonably tight, thereby eliminating any great amount of infiltration. (2) Army sewage is concentrated, not only because there is little infiltration of ground water but as well because there is no industrial sewage present. (3) Many times grease accumulations in municipal sewerage systems lodge back in the lines and are then flushed out during storms, at which time the surge is apt to be by-passed and never enters the plant to be analyzed. (4) It should be remembered that the average civilian in the United States uses only about 1.85 oz. of grease per day—which is 5.7



Automatic skimmer for Graver "Flexidrive" clarifier.



Sectional elevation of Dorrco "Vacuator," which is very effective in flotation of grease.

billion pounds per year for 135,000,000 population—for all purposes, whereas the average soldier is given 4 oz. (5) Based on sewage flow, the average per capita grease waste in Cleveland is 1.14 oz. or .09 lb. of grease per day and in Columbus it is said to be 1.12 oz. of grease, which is a very high percentage of what the civilian uses. (7) The soldier in the Fifth Service Command wastes perhaps .0642 pound or 1.025 oz. per day despite the fact he is given 2.18 times as much fat and grease.

The figures seem to show that the per capita civilian waste directly into the sewer is from 60 to 62% of the edible fat and grease supplied, whereas the soldier throws away only 25 to 26%. Regardless of these figures, the Army is not yet satisfied that it has reached the reasonable limit for conservation and salvage of edible grease. It is believed that, by diligence in the future, the Army sewage grease content may be reasonably reduced to approximately 90 ppm as an average, which would equal an average wastage per capita per day of .84 oz. or about 20% of the issue.

Concordia, Kansas, Uses Prisoner-of-War Labor

By E. W. POWELL
City Engineer, Concordia, Kansas

WHEN Concordia, the County Seat of Cloud County, Kansas, with a population of some 6,000 people, found itself in the same fix as most towns in the United States, with no extra labor for performing some needed municipal work and with no market to draw from, it decided to use prisoners of war, as a large number of them were available from a nearby camp. These were used for deepening and cleaning 5,000 feet of open storm sewer ditch, extending from the end of a covered storm sewer in the north part of town to discharge into a natural water course, which carries the storm water to the river. This ditch was silted up to some extent due to flash floods and was badly choked with weeds, brush and debris.

Nine prisoners were used by the city each day, but, due to the fact that there were more men than jobs, a new bunch was sent each day. In all, more than 200 men worked on this job. However, on work that requires some preliminary training, the employer may have the same men every day, by requesting this of the proper officials.

The city furnished all tools, which in this case consisted of shovels, scythes, pitchforks, axes, etc. The material removed from the ditch was shoveled into trucks and hauled away.

There was a noticeable difference in the skill of the individuals in a group of prisoners, in the manner in which they handled their tools, and especially in the manner of cutting the level and back slope, indicating that they had worked at varied occupations. A few very hot afternoons occurred but they did not seem to mind it much, as they are mostly young men and it would appear that they seem glad to be out of the war.

The city used a number of these men in cleaning weeds out of the Municipal Cemetery. They were very careful and thorough at this work and seemed much interested in the wild rabbibts to be found by anyone engaged in this type of work in this community.

War prisoners have also been used by a great number of farmers in this community at such tasks as wheat and hay harvesting, corn husking, etc. The National Reclamation Association has a proposed project in this community to build a diversion dam in the river and irrigate several sections of land, and it is understood that War Prisoners may be used on this work.

To secure the services of these prisoners, it is necessary to first post your job with the Federal Re-employment office, stating the nature of the work and the pay offered, and to agree to use free labor if it is available. This is done to prevent free labor from having to compete with prisoner of war labor. If no free labor can be furnished by the Re-employment office, you then transmit, in writing, to the proper officials of the prison camp, your desire to secure prisoner of war labor, stating the number of men wanted, what you expect them to do, the exact location of the job and the approximate time required to do it. You then sign a contract with the Government, whereby you agree to pay the prevailing wage scale (which in our case was 40 cents per man hour). This must be paid to the Federal Government by cashier's check upon completion of the work. The prisoner receives 80 cents per day for each day of work completed.

The prisoners are transported from the camp to the job in Army trucks under proper guard of the United States Army. The guards accompany them everywhere they go and the nature of the work must be such that the prisoners are in view of the guards at all times. The prisoners are comfortably dressed in blue denim with a large P W painted across the back of their jackets and the seat of their pants.

No attempt is made to mistreat the prisoners or force them to work. However the employer is granted the right to send them back to the camp if he is dissatisfied with their services. It was our experience that these prisoners seemed cheerful and willing to work. They appeared clean and well cared for and in good physical condition. Many of them speak enough English to obey orders and carry on some conversation.

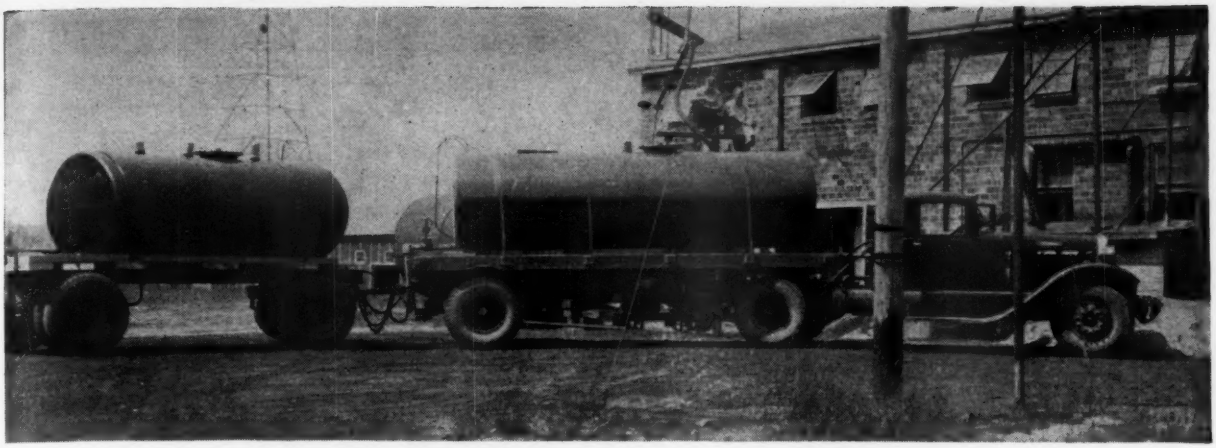
A careful study was evidently made by the personnel of the United States Army on the best methods of handling these prisoners so as to obtain the greatest amount of efficiency from their labor, as the employers of them were interviewed and suggestions were asked for as to better methods of working them. Since there are many more prisoners than there is work that they can do in one community, several side camps have been established. This answers the transportation problem and permits the serving of a large area with prisoner of war labor.

It seems to be the common expression of the citizens of this community that they hope the Germans are treating our boys who are their prisoners as well as we are treating the Germans that are held here.

(Editorial note: It is reported that more than 10,000 Axis soldiers are at work cutting trees in American forests to lessen the lumber and pulpwood shortage, and that several times this number will be so employed. They are employed by logging contractors and paper companies.)

Fees for Collecting Garbage

Fees for the collection of garbage may now be fixed or revised by cities without reference to OPA, under a recent exempting amendment of that agency.



Trailers used for hauling brine from Manistee to Oceana County roads.

Oceana County Uses a Million Gallons of Brine a Year

Because of its location near sources of brine which possessed characteristics favorable to dust laying, the county found the use of this brine cheaper than the flake calcium chloride which it had used previously.

By C. M. STOVER
County Engineer, Oceana County, Michigan

OCEANA COUNTY, MICHIGAN, in the heart of the fruit belt on the east shore of Lake Michigan, is the home of the largest shifting sand dunes in the United States, visited by many thousands of tourists each year. One of the prime duties of the Road Commission of that county is to abate the dust and maintain the 200 miles of gravel roads in as smooth a condition as possible. For this purpose they used flake calcium chloride on many of the roads, but the highway revenues were not sufficient to permit this treatment of all the roads that need a dust palliative.

Brine is produced by oil wells in the county and in 1935 twenty miles of road were treated with 200,000 gallons of brine, taken from local wells so that the haul was short. This brine contained 5.05% calcium chloride, 15.1% sodium chloride and 1.68% magnesium. The next year an average of 15,000 gallons of this brine liquor per mile was applied to 60 miles.

The results in laying the dust and retaining the moisture in the road were fine, but the reaction of the public was not so favorable, due to excessive rusting of car parts and destruction of foliage by the brine-coated dust. Many maple trees showed the burning action of the slight amount of dust blown on them, and foliage of apple trees close to the road was especially susceptible. The commission therefore decided in 1937 to use local brine on only those roads that did not traverse the fruit section of the county.

At Manistee, Mich., brine is pumped from the sylvania sand, much deeper and heavier than our local supply and much better for our purpose, since the sodium chloride content is but 3.5%, the calcium chloride is 16.0% and magnesium chloride 8.3%, a total of 27.8% solids. The specific gravity is 1.26 and the freezing point about 65° below zero. The outstanding advantage of this brine over our local supply is the small amount of sodium chloride and the comparatively large amount of calcium and magnesium, which are the desired chemicals. This brine it was proposed to try on the roads through the fruit section.

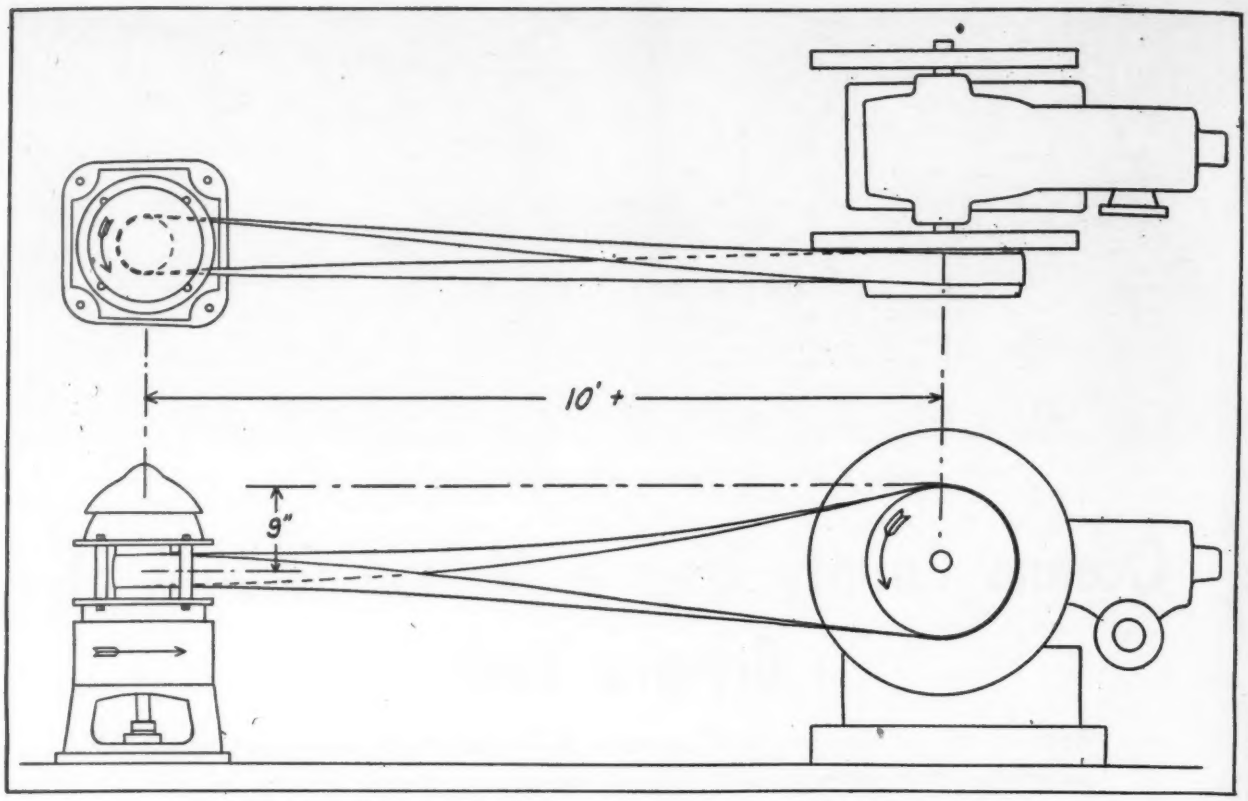
There are two sources at Manistee from which this brine can be obtained, the Rademaker Chemical Co. and the Great Lakes Chemical Co. The latter is six miles nearer and was used as our source of supply.

While hauling from our local wells, we used an 800-gallon tank, with a gravity feed to a 2″ pipe ten feet long, perforated with ¼″ holes spaced 2″ apart. The average length of haul from our local supply was 12 miles. From the Manistee wells the dead haul was forty-five miles and the average haul was sixty miles.

To offset the increased haul, the Road Commission purchased a 7-ton Federal truck and two Fruehauf trailers. One, a semi-trailer, carried 3,000 gallons, while the four-wheeler carried a 2,000-gallon tank. When loaded, the net load of brine amounted to 52,500 lbs. of liquid containing 14,595 lbs. of solids—a pretty fair load.

The brine from the Great Lakes Chemical Co. proved to be so successful that the Commission discarded the local brine entirely. There was no searing of the foliage along the road side and the results as a dust palliative were as good as could be obtained by the application of flake chloride.

(Continued on page 68)



Sketch showing how a utility type gasoline engine temporarily replaced a burned-out motor.

"How Soon Can You Rewind My Motor?"

If a vertical motor on a pumping unit burns out, there are several possible substitutes that could be used temporarily. One of them is described in detail.

By ARCHER B. STUART
City Engineer, Healdsburg, California

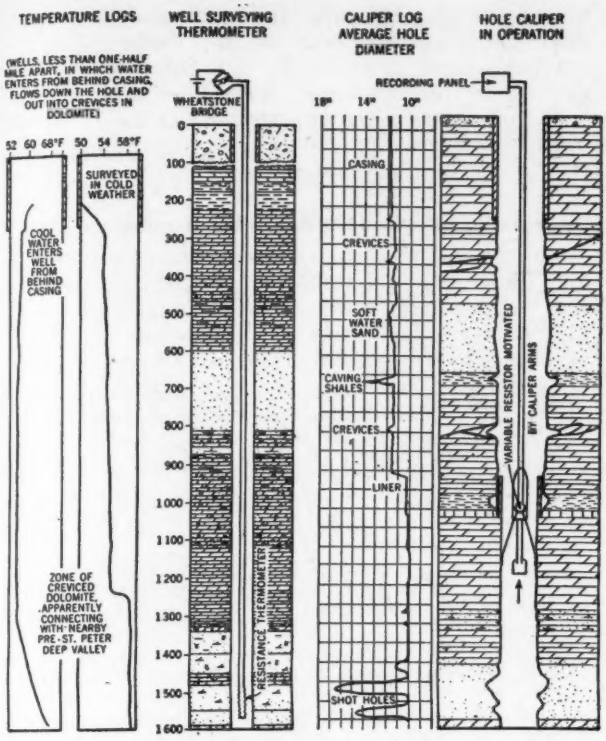
WE RECENTLY received a frantic call from a pump manufacturer who wished to borrow one of the special vertical motors on our pumping units. Ours were the only motors in the West that would replace the burned out motor in an Army air field disposal plant, where conditions were quite critical with raw sewage running down the main street. (I can feel for the police detail from the guard house, armed with scoops and chloride of lime in addition to the customary nail-pointed sticks.)

Since we could spare one motor at this time of year it was shipped (prepaid) without quibbling, but I wondered why such a procedure, with its attendant delay, should be resorted to. It seemed to me that they should have had a spare unit (unless L-221 had burned up *all* their motors), or that they could have improvised a temporary drive, or rigged up a water ejector from their fire service lines. The water ejector is the simplest for low lifts, but an emergency drive can readily be adapted to any polyphase motor. I have used this ruse for years to help out local farmers and industries, and had assumed that others did the same thing; but if the pump manufacturer did not suggest it in the above case, possibly the practice is not generally prevalent.

The method is shown in the accompanying sketch in which a utility type gasoline engine is pressed into service; but I have used the power take-off on tractors, any available electric motor of sufficient size, or even the rear wheel of a truck. This last drive is not recommended, however, unless both rear wheels are jacked up and the differential locked.

The stator of the damaged motor is removed for repairs and is temporarily replaced by suitable bolts and spacers to support the upper end bell rigidly in proper position. This spacing may be done in several ways depending on the motor size and the construction of the end bells. The simplest means is to use pipe bushings, but if the pipes do not seat squarely at the ends they may be trimmed to fit, or pieces of strap iron may be cut and set adjacent to each bolt in the machined rings on the end bells which match the stator

(Continued on page 78)


TEMPERATURE LOGS
(WELLS, LESS THAN ONE-HALF MILE APART, IN WHICH WATER ENTERS FROM BEHIND CASING, FLOWS DOWN THE HOLE AND OUT INTO CREVICES IN DOLOMITE)
52 60 68°F 50 54 58°F
SURVEYED IN COLD WEATHER
COOL WATER ENTERS WELL FROM BEHIND CASING
ZONE OF CREVICED DOLOMITE, APPARENTLY CONNECTING WITH NEARBY PRE-ST. PETER DEEP VALLEY
WELL SURVEYING THERMOMETER
WHEATSTONE BRIDGE
RESISTANCE THERMOMETER IN INSULATING TUBE
CALIPER LOG AVERAGE HOLE DIAMETER
HOLE CALIPER IN OPERATION
RECORDING PANEL
18" 14" 10"
CASING
CREVICES
SOFT WATER SAND
CAVING SHALES
CREVICES
LINER
SHOT HOLES
VARIABLE RESISTOR MOTIVATED BY CALIPER ARMS
FLUID RESISTIVITY LOG OF WELL IN WHICH FLUID IS CIRCULATING
RESISTIVOMETER IN OPERATION
OHMS M²M
AFTER SALTING
NATURAL
WATER ENTERING WELL FROM BEHIND CASING
WATER FLOWING OUT INTO PERMEABLE SANDSTONE
WATER ENTERING WELL FROM DOLOMITE CREVICES
WATER FLOWING OUT INTO PERMEABLE SANDSTONE
TOTAL DEPTH WHEN LOGGED
CURRENT ELECTRODE
MEASURING ELECTRODES
INSULATED HOUSING
CURRENT METER IN OPERATION
CONTACT POST

Temperature logging of well. **Caliper logging of well.** **Resistivity survey of well.** **Current meter survey of well.**

Application of Geophysics to Groundwater Problems

Conclusion of article in the May issue. Miscellaneous geophysical methods. Problems clarified by logging. Integration of geophysical and geological data.

By Carl A. Bays and Stewart H. Folk

Geologist and Engineer, and Associate Geologist, respectively, Illinois State Geological Survey

Additional Geophysical Methods for Use in Water Wells

The foregoing logs have provided much new information and increased our understanding of groundwater problems in Illinois. It is apparent that there are a number of improvements possible in the technique of operation and in the interpretation of results from the present methods. In addition it seems probable that a number of other geophysical methods or auxiliary instruments might have useful application in groundwater problems in Illinois and elsewhere.

Various types of fluid-samplers, which take samples at different depths, are in use in various industries and fields of investigations.

The camera has been successfully used to inspect the lithology and physical characteristics of the wall rocks in water wells and is reported to have been used in oil wells. It is believed that use of a camera would be invaluable in fishing jobs and inspecting casing and liners.

Radio-activity surveys (gamma ray and neutron) are used to log formations in cased and uncased portions of oil wells. It seems likely that these methods of investigation, particularly as applied to the formations behind the casing, should prove useful in some water-well problems. For instance, it may permit the identification of both glacial and bedrock aquifers which have been cased-off, thereby giving new information from existing wells.

Water Well Problems Clarified by Geophysical Logging

In drilling, completing, and producing water wells, many problems arise. The data needed for the solution of some of those problems can be supplied by subsurface geophysical methods. It must be noted that the geophysical evidence of subsurface conditions is largely indirect, and for sound interpretation of the data more than one line of evidence bearing on any problem is desirable and in many instances must be

supplemented by some knowledge of the subsurface geological conditions.

In wells that produce from several zones, as do most of the deep wells in northern Illinois, it is desirable and in many cases essential to know the depths and thicknesses of all the water-producing zones, the amount, quality, and temperature of water produced from each, and the differences between the hydrostatic heads of different zones. Most of this information could be secured during the drilling of the wells if extreme care were used in detailed observation and recording of the action of the drilling tools, character of the cuttings, change in composition and volume of fluid in the well, and if each possible producing zone were separately tested with the formation-tester or by pumping. Unfortunately these precautions are seldom taken, so that for too many wells, particularly those drilled some years ago, little is known other than that they are holes in the ground of a certain diameter at the top. If the yield is insufficient, or if the quality and/or temperature is undesirable, detailed data on the subsurface conditions are needed so that the well can be worked over intelligently and economically and the desired quantity and type of water procured. The zones that should be cased off, casing and liners that should be lowered or replaced or cemented, zones that merit shooting or acidizing, and all of the other conditions within the well that affect its production must be recognized. Most of those conditions can be determined from geophysical logs of the well. Thus one of the most important contributions of geophysical surveying has been that of supplying as complete information as possible on old wells as a guide to working them over.

In some cases the question arises as to whether or not deepening a well will increase the supply of water, and if so, whether or not those deeper supplies will be of usable mineral content and temperature. The exact correlations with other wells made with electric logs, and the determination of geothermal gradients from temperature surveys afford good bases for estimates or predictions of conditions at greater depths in any well.

Where considerable differences in hydrostatic head exist in the various aquifers of multi-zone wells, some zones may take or "thieve" water from the wells. By use of temperature logs, fluid-resistivity logs, and current-meter logs in conjunction with the electric log, such thieving zones can be recognized. If the thieving zone is a creviced dolomite, as is frequently the case in Illinois wells, the caliper log also is helpful in locating it.

Some wells are polluted or contaminated by surface or near-surface waters that enter through holes in the casing, through crevices in the rock below the casing, or from behind an imperfect casing seat. By using temperature, current-meter, and/or fluid resistivity surveys in conjunction with electric logs and caliper logs, the place of entrance of such waters can usually be determined. With that information the proper remedial measures, such as replacing the defective casing, extending casing below the crevices or poor casing seat, or cementing, can be employed and the pollution or contamination be eliminated.

Caliper logs are valuable aids to re-working old wells because they locate tight spots and zones of caving shales, conglomerate, or soft sandstones in the wells.

In addition to the location of casing and liners, it may be important to know the location of lost tools or junk in the hole. As has been shown, the electric log gives good measurements of the casing and liners and in some wells locates the position of drilling tools, joints of old air-lift pipe, and other steel or iron articles that might have been dropped in the hole.

Where fresh-water sands are interbedded with sands carrying salt-water, the salt-water sands can be differentiated from the fresh-water sands by the resistivity curves of the electric logs or by production tests with the formation-tester.

Integration of Geophysical and Geological Data

Through compilation and comparison of geophysical data derived from a number of methods of investigation, supplemented with all available geological and production data from the well in question and nearby wells, a reasonably good picture of subsurface conditions can be obtained and many of the problems of groundwater production can be solved. To integrate all such information, a composite log of each well is prepared, on which is displayed all the phases that have been investigated. The composite logs now made by the Illinois Geological Survey present data forming the basis for the following:

1. A detailed log of the lithology of the uncased portions of the well based on microscopic study of cuttings from the well or nearby wells and the electric log and a sample study of the cased portions of the well.
2. Exact measurements of the casing and liners, both as to depths and inside diameters, and some knowledge of their condition.
3. Location, thickness, and relative importance of the water-producing zones.
4. Location of "thieving" zones.
5. Approximate salinity of the water in the well bore, and probable zones of production of waters of different salinities.
6. Temperature of the water in the well bore and the approximate temperature of water from different zones.
7. Caving zones that have not been cased off.
8. Circulation conditions under non-operating conditions.
9. Critical production or well conditions such as collapsed or corroded liners, poor casing seats, location of iron or steel "fish," etc.
10. Effects of shooting, acidizing, caving, and other special conditions within the well.

Pushing Iron Pipe Across a Swamp

An unusual method of laying cast iron pipe was employed by the R. J. Reid Contracting Co. in laying about 1500 ft. of 12″ gas main at Mobile, Ala. The land was a mucky swamp where it was impossible to use trucks or tractors for bringing in the pipe. The plan adopted was to prepare, on firm ground at the edge of the swamp, a skidway made with 40 lb. rails spaced 12″ apart and spiked to crossties, on which the pipe was jointed together, using Doublex Simplex Lock Joints. This skidway was 35 ft. long and laid on a 5 degree pitch, and led to a trench that was dug through the swamp 24 in. deep, the water standing 16 in. deep in it. The pipe was pushed down the skidway and through the trench with a Caterpillar tractor for 900 ft.; then a cable was attached to the forward end and pulled by a power winch mounted on a truck on firm land at the other side of the swamp, the tractor also pushing at the same time.

The front end of the pipe line was plugged, both to keep out the mud and to make the pipe line buoyant. Men stationed along the line cleared away mud that collected in front of the bells and kept them clear of stumps or other obstructions.

Sewer Service Charges at Eugene

At Eugene, Ore., a sewer service charge collected with water bills has provided an accumulation of more than $100,000. The revenue is being set aside in a sinking fund to be used for the construction of a sewage disposal plant.

General view of bridge after constructing the timber additions.

Wyoming Concrete Bridge Widened With Treated Timber

Width of bridge doubled by adding a trestle-supported laminated wood floor on each side. No visible joints between old and new floors.

THE Wyoming State Highway Department used pressure creosoted wood construction to widen a concrete bridge which had become too narrow to handle the volume of traffic crossing it daily. The original bridge, constructed in 1927 over Crow Creek on U.S. Route 30 on the west side of Cheyenne, was a reinforced concrete structure 140 ft. long, with a 27-ft. roadway, but carried no sidewalks. In this form it had a somewhat brief existence of ten years before traffic changes made alterations necessary.

By 1937, the increase in pedestrian travel along the road had reached a point where a sidewalk was required. This was obtained by the erection of two steel deck plate girders on the north side of the concrete structure to support a 5-ft. walkway. By 1941, increased automobile traffic necessitated an increase in the width of surfacing on U. S. Route 30 to 54 ft. on either side of the bridge, which, in turn, made mandatory a similar widening of the roadway across the bridge. This was accomplished by additions of creosoted timber on either side.

The pedestrian bridge on the north side was moved out far enough to permit the insertion of a 5-span timber trestle on 3-pile bents to carry one new traffic lane and a similar trestle on the south side on 4-pile bents for another vehicle lane and an additional sidewalk. The trestles were decked with timber stringers and 3x6-in. laminated wood floors and covered with a bituminous mat surface identical with that on the highway and the concrete portion of the bridge. The sidewalks were separated from the roadway by concrete curbs 18 in. high. The outside edges of the sidewalks were equipped with 4.5-in. round pipe posts and rails, painted with aluminum. These posts have a spread base, and where placed on timber curbs or surfacing retainers were bolted down through the floor for support.

Noteworthy in this composite structure is the effective way in which the joint between the concrete and laminated wood floors was made. The grade line of the timber additions was carried as closely as possible to that of the original concrete structure. There were, however, unavoidable variations of possibly an inch here and there due to imperfections in the original concrete form work or to differences in the two types of design involved. The adjacent floor edges were brought to the same level by applications of a bituminous mixture prepared for this purpose and the joint covered with a row of asphalt plank. A bituminous wearing surface was then spread over the entire 54 ft. of roadway, covering the wood floor, the concrete slab and the asphalt plank for a depth of several inches. The riding surface on the widened bridge has now been in service for a considerable period and has remained free from cracks. The appearance of the entire superstructure, visible to the ordinary motorist and pedestrian, is that of structural unity and adequate design.

The piles and timbers in this work are Douglas fir pressure treated by an empty-cell process with a final retention of 8 lbs. of creosote per cubic foot of wood.

J. G. Smith is chief engineer and superintendent, and W. H. Fisher is bridge engineer of the Wyoming State Highway Department, with headquarters at Cheyenne.

The above is reprinted from *Wood Preserving News*, to which we are indebted for the illustration also.

Making Culverts From Penstock Pipes

(Continued from page 19)

built at so low a cost. If it later should appear that they are beginning to rust, a concrete lining may be installed.

Our putting through these projects in war time we believe was justified, in that no essential war materials were used and no additional labor, as they were sandwiched between regular maintenance jobs of the city's force.

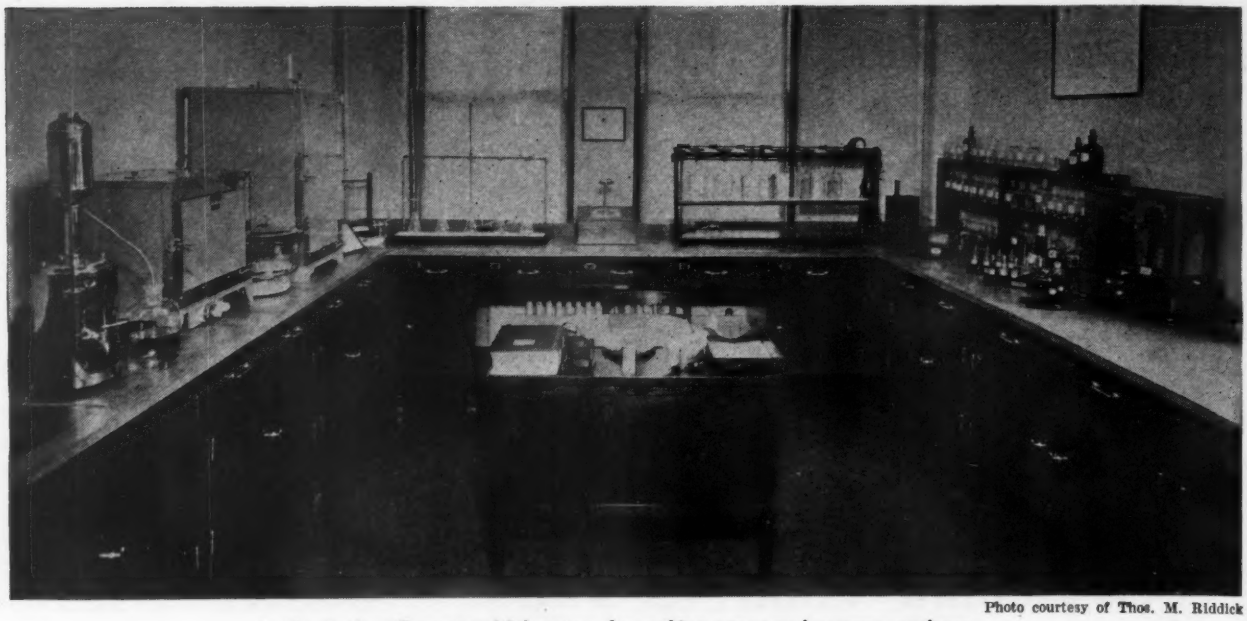


Photo courtesy of Thos. M. Riddick

Fig. 1—A well arranged laboratory for making water and sewage analyses.

Water and Sewage Chemistry and Chemicals

This text was originally prepared by W. A. Hardenbergh, with the advice and assistance of Paul Weir, C. R. Cox, A. E. Griffin, Harry Eichenauer, W. W. Towne, E. A. Sigworth, Lloyd K. Clark, A. J. Fischer, Ellis K. Phelps, A. S. Behrman, T. C. Schaetzle, Floyd G. Browne and Richard Messer. Major Clark is now in the Southwest Pacific, and Col. Behrman, Capt. Towne and Col. Hardenbergh are at present on duty in this country, though two of them have served overseas. This revision has been prepared to aid the newcomers to the water and sewage field, more than 15,000 reprints of the original article in PUBLIC WORKS for December, 1940, having been long since exhausted.

IN modern water and sewage plant design and operation, some knowledge of chemistry and chemicals is an absolute necessity. Modern sewage treatment procedures and controls are based on chemical tests and laws, while chemistry is an essential element in the treatment of water, whether for human consumption or for industrial use. It is desirable for operators and engineers to know the principles underlying the methods and materials they use, even though a basic knowledge of chemistry cannot be obtained by them.

Elementary Terms and Symbols:

Elements.—In chemistry, elements are those substances that cannot be divided into simpler substances. Each element is made up of and consists wholly of atoms of only one kind. Altogether there are about ninety elements, of which only 15 or 20 are commonly considered in water and sewage work, though many others may be used in connection with tests or analyses in this field. A list of chemical elements frequently or occasionally used in water and sewage treatment, with their symbols and atomic weights is shown in Table I.

Nomenclature. — In addition to their common or popular name, chemicals are represented by symbols consisting of the first or the first and another letter of their Latin (or occasionally Greek) name. For example Ca is the symbol for calcium; Fe is the symbol for iron, for which the Latin term is ferrum; Ag is used for silver, or argentum; Au is used for gold, or aurum; Pb for lead, or plumbum; N for nitrogen; H for hydrogen; O for oxygen; C for carbon; Cl for chlorine; Cu for copper (Latin cuprum); and Na for sodium, to mention only a few common elements.

Combinations. — All matter is composed of combinations of the elements according to chemical laws. Most combinations are simple and are composed of only two or three elements, though others are very complex. Common salt, which is a combination of sodium and chlorine; and water, which is composed of hydrogen and oxygen, are examples of simple common compounds; while the recently developed insect killer, DDT, or dichloro-diphenyl-trichlorethane, is a complicated compound of several elements. The well-known and commonly used hypochlorite is a combination of calcium, chlorine and oxygen. Lime is made up of calcium and oxygen, but may also contain hydrogen.

Atomic Weights. — Each known chemical element has an atomic weight. The atomic weight is relative only, is based on an assumed atomic weight of 16.00 for oxygen, and represents the true relative weights

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of the various elements. The atomic weight is important because two or more elements always combine in proportion to the atomic weights of the elements composing the compound. In Table I are shown the atomic weights of various elements.

TABLE I

Chemicals Used in Water and Sewage, with Symbols and Atomic Weights.

Chemical	*Symbol*	*Atomic Weight*
Aluminum	Al	26.97
Barium	Ba	137.36
Calcium	Ca	40.08
Carbon	C	12.01
Chlorine	Cl	35.46
Copper	Cu	63.57
Hydrogen	H	1.01
Iodine	I	126.93
Iron	Fe	55.84
Magnesium	Mg	24.32
Manganese	Mn	54.93
Mercury	Hg	200.61
Nitrogen	N	14.01
Oxygen	O	16.00
Platinum	Pt	195.23
Potassium	K	39.10
Silicon	Si	28.06
Silver	Ag	107.88
Sodium	Na	23.00
Sulfur	S	32.06
Phosphorous	P	31.02
Lead	Pb	207.21

The figures given above are the International atomic weights for 1937, correct to the nearest two decimal places.

Valence. — Chemicals have a certain quality or power of combining with each other which is called valence. Using the valence of H as 1, the valence of the other elements is determined. Thus, since H and Cl unite to form HCl, the valence of Cl is also 1; two atoms of H unite with one of O to form water, or H_2O and therefore the valence of O is 2. Some elements have different valences under different conditions. For instance, CO (carbon monoxide) indicates that C has a valence of 2; but in CO_2 (carbon dioxide), C has a valence of 4.

In general, valence is not highly important to the man engaged in water and sewage work and who is interested only in the terms and usages commonly employed in such work.

Acids.—An acid is a compound that contains hydrogen which may be replaced by the metal of a base to form a salt. Thus HCl (hydrochloric acid) may be changed to NaCl (common salt) by replacing the H with Na. H_2SO_4 (sulfuric acid) is changed to $CaSO_4$ (calcium sulfate or gypsum) by replacing the H with Ca.

Bases.—The oxides and hydroxides of the metals are called bases. They react with acids to form salts, as stated above. In this connection, the term "metal" is not restricted to copper, lead, iron, tin, silver, gold, etc., but includes potassium, sodium, calcium, magnesium, etc.

An example of a base is CaO (calcium oxide or lime) which combines with H_2SO_4 to form H_2O and $CaSO_4$; or with carbonic acid, H_2CO_3 to form H_2O and $CaCO_3$ (calcium carbonate).

Specific Gravity.—Liquids, solids, and gases have specific gravity. In measuring the specific gravity of liquids and solids, they are compared to water, the specific gravity of which is 1.00. A liquid or solid that has, for instance, a specific gravity of 1.85, is therefore 1.85 times as heavy as water. The specific gravity of gases are determined by comparison to pure, dry air. A gas having a specific gravity of 1.85 weighs per unit of volume (as 1 cubic foot) 1.85 times as much as an equal volume of air at the same pressure and temperature.

In certain types of measurements, specific gravity is important.

Units of Measurement:

Before proceeding further, it is desirable to consider units of measurement. Chemical analyses must be exact in order to provide necessary bases for chemical reactions, and must be stated in terms that mean the same to everyone. Several methods are in use to indicate the strength of solutions or the amount of a material present in water or sewage. The most common methods are: Parts per million, abbreviated p.p.m.; grains per gallon, abbreviated gpg.; pounds per million gallons; and, in the metric system, milligrams per liter, which is equivalent to parts per million.

The U. S.-English System.—This system is based on pounds and gallons. In using this system grains should not be confused with the grams of the metric system, as 1 gram equals 15.43 grains. There are 437.5 grains in an ounce, and 16 ounces in the ordinary avoirdupois pound, or 7000 grains per pound. Therefore 1 grain per gallon equals 1 pound in 7000 gallons, or 142.9 pounds per 1,000,000 gallons (1,000,000 ÷ 7000 = 142.9). Since 1 gallon of water weighs 8.34 pounds, 1 gpg equals 142.9 ÷ 8.34 or 17.1 parts per million. Therefore, 1 gpg = 17.1 p.p.m. = 142.9 pounds per million gallons.

Canadian or Imperial gallons are larger than U. S. gallons; the U. S. gallon is 0.83 the Canadian or Imperial gallon. The proportions given above must be modified accordingly.

Since the U. S.-English measurements are used almost exclusively in computing chemical dosages, plant operators should be thoroughly familiar with them.

Example: The hourly flow of water is 55,000 gallons. It is necessary to add ½ gpg of lime to the water. How much is required? Solution: ½ gpg = 71.4 lbs. per m.g., or 7.14 lbs. per 100,000 gallons. For 55,000 gallons, there will be required 0.55 x 7.14 = 3.93 lbs.

The Metric System.—In the metric system, the standard unit of volume is the liter (slightly more than one quart). A liter contains 1,000 cubic centimeters (usually abbreviated cc.). The term milliliter, which means one one-thousandths of a liter (and is abbreviated ml) is now more generally used than cubic centimeter, but for all practical purposes the terms are interchangeable. The standard unit of weight is a gram, which is the weight of one cc.

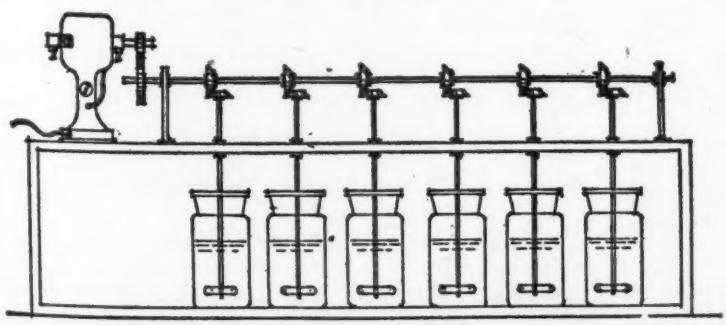

Fig. 2—A handy stirrer for laboratory use. (Courtesy National Lime Ass'n.)

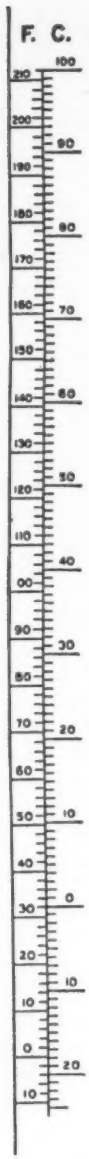

Fig. 3 — Above a scale by which Fahrenheit and equivalent Centigrade temperatures may be read directly.

(or ml.) of water at a standard temperature. The kilogram (kg.) is 1,000 grams (about 2.2 pounds); the milligram (mg.) is one one-thousandth of a gram. It is convenient to remember that 1 mg. per liter equals one part per million.

Temperature.—Both the Fahrenheit and the Centigrade scales are used to measure temperature. The freezing point of the F scale is at 32°, and of the C scale is at 0°. The F boiling point is 212°, the C is at 100°. Fig. 3 herewith permits direct reading of the two scales.

Baume.—The Baume scale is used in the chemical industry. The following data are abstracted from General Chemical Co. Products Book:

In nearly all instances the specific gravity or density in water of solutions of pure chemicals, such as acids, alkalies and salts, varies in proportion to the amount of these constituents present. This fact is used to determine the strength of solutions by obtaining their densities. The method is rapid, sufficiently accurate for most purposes and avoids the necessity for making chemical analysis.

The terms density and specific gravity, while strictly not synonymous, are generally interchangeable in representing the weight of a volume of liquid compared with the weight of an equal volume of water. Since the densities of liquids vary with the temperature, the temperature must always be specified. Chemical manufacturers in the United States have agreed on and use 60° F as a basis for specific gravity and most tables are prepared on this basis.

While specific gravity to be accurate must be expressed to four decimal places by figures such as 1.0762, the Baume scale permits the number of decimal figures to be reduced. The relation of the Baume scale to specific gravity is as follows:

$$\text{Degrees Baume} = 145 - \frac{145}{\text{Sp. Gr.}} \text{ for liquids heavier than water.}$$

$$\text{Degrees Baume} = \frac{140}{\text{Sp. Gr.}} - 130 \text{ for liquids lighter than water.}$$

The determination of the specific gravity of a solution is done by means of a Baume hydrometer. When determinations are carried out properly, results can be obtained which are accurate within 0.20° Baume, which in the case of sulfuric acid is equivalent to Sp. Gr. 0.0004 at 66° Baume, or to within 0.11%. This accuracy compares favorably with that obtained by chemical analyses and is satisfactory for most purposes. To obtain this accuracy, reliable, high-grade hydrometers must be used.

Example.—A sample of sulfuric acid (H_2SO_4) has a specific gravity of 1.8354. What is this acid on the Baume scale?

Solution.—The Baume formula is:

$$\text{Baume} = 145 - \frac{145}{\text{Sp. Gr.}}$$

$$= 145 - \frac{145}{1.8354}$$

$$= 145 - 79.00 = 66°.$$

This is the standard grade of sulfuric acid, with 93.19% H_2SO_4.

Example.—What is the specific gravity of an acid with a 60° Baume?

Solution.—Using the above formula,

$$145 - \frac{145}{\text{Sp. Gr.}} = 60$$

$$\text{Sp. Gr.} \times 85 = 145$$

$$\text{Sp. Gr.} = 1.70588.$$

Conversion Factors.—A number of excellent tables of conversion factors are available for rapidly obtaining metric or other equivalents. Perhaps the most widely used tables for ordinary municipal work are those issued by the Dorr Co. Availability at this time is uncertain. If such tables are needed, write the Editor, who will try to obtain a copy.

Chemical Terms and What They Mean:

Proportions and Combinations. — Any compound made up of any combination of elements will always be in proportion to the atomic weights of the respective elements in the compound. See Table I. That is, a compound of one atom of iron and one atom of sulfur, always will be in the proportion of 55.84 parts of iron to 32.06 parts of sulfur. In all combinations of chemicals, the relative weights are in accordance with the atomic weights.

This compound of iron and sulfur is iron sulfide; under proper conditions 55.84 parts of iron and 32.06 parts of sulfur will combine, forming 87.90 parts of the sulphide. If there is an excess of either iron or sulfur, the excess will be unchanged and will not combine. Likewise, in forming common salt, NaCl, there will be 23.00 parts (grams, pounds or tons) of sodium (Na) to 35.46 parts (grams, pounds or tons) of chlorine (Cl). If there are 30 pounds of sodium to 35.46 pounds of chlorine, 7 pounds of the sodium (30-23) will not combine with the chlorine, but will remain intact as sodium.

Thus in any chemical compound, the proportions by weight of its elements are always the same.

There are some chemical elements, however, that combine in more than one proportion to form more than one compound. Carbon and oxygen may unite in the proportion of 12.01 to 16.00 to form carbon monoxide (CO), a gas that is known for its poisonous effect when inhaled; but carbon and oxygen also may unite to form carbon dioxide (CO_2) in which case the proportions are 12.01 parts of carbon to 32.00 parts of oxygen.

These rules apply to all other compounds also. In each case a simple ratio exists between the weight of the elements, and the composition of the compound will be constant and will always be formed when the conditions are the same. Also, when a fixed weight of one element units with several weights of another element to form compounds, these several weights are always in a simple ratio to each other—that is, they will be 2, 3, 4 or 5 times as great as the least weight that will combine.

Solutions and Suspensions.—When a solid is dissolved in a liquid it forms a solution; gases or liquids may also be dissolved in a liquid in a like fashion to form a solution; and even some solids may be dissolved in other solids. Examples of a solid dissolved

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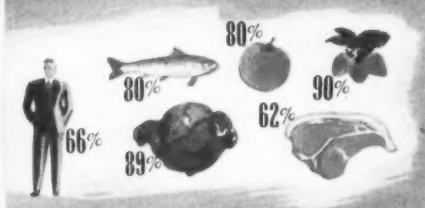
Interesting Facts About WATER

A CHEMICAL MYSTERY

ater is H_2O—two parts hydrogen and one part ygen. As separate gases they are highly explosive. some mystery of nature, H_2O combines atoms to ke water.

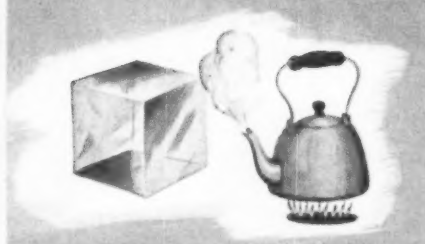
HOW MUCH OF EARTH'S SURFACE IS WATER?

out 16,000,000 tons of water fall on the earth ry second. The earth's surface is nearly three- rths water. If leveled off it would be covered with ter to a depth of two miles.



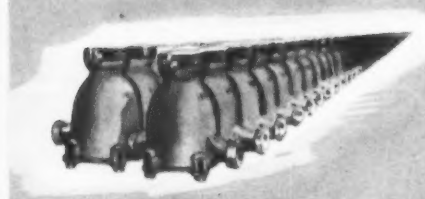
WATER IN FOODSTUFFS

foodstuffs contain water; some as high as 95%. average human body contains about twelve llons of water, comprising about 66% of the dy. The brain contains about 85% water.



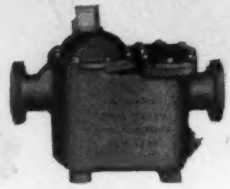
WATER EXPANDS—HOT OR COLD

ter will expand both above and below its point maximum density. At freezing it expands about ; at boiling point, about 164%.

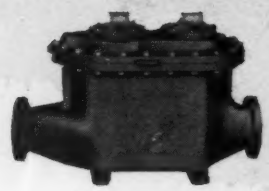


HOW MANY METERS?

s of millions of water meters have been produced e metering was introduced by Utilities several ades ago. Metering is the fairest and most itable method of computing water usage.



GEM VELOCITY



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in a liquid are aluminum sulfate or sodium carbonate dissolved in water; while a water solution of chlorine is an example of a gas dissolved in a liquid.

There are some substances that do not dissolve, as activated carbon. Where the particles of a solid are spread or dispersed through the liquid in a very finely divided state, the mixture is called a suspension. A mixture of Fullers earth and water, such as is used in making turbidity standards, is also a suspension.

Solutions are called dilute when they are weak, that is, when they contain only a small amount of dissolved material; or concentrated if very strong; or saturated, at which point the liquid is unable to take up any more of the solid or gas.

For proper use, the strength of solutions must be known, and in laboratory work solutions of a definite, known strength are used in order to make chemical calculations possible. The preparation of such solutions having a definite strength will be discussed later.

Mixtures and Compounds.—A mixture of two atoms of hydrogen and one atom of oxygen does not produce water, which has the chemical formula of H_2O; but if a properly proportioned mixture of these two gases is ignited, as by an electric spark, the two gases combine explosively to form water. Hydrogen gas and chlorine gas when mixed together and exposed to sunlight form a compound, HCl, or hydrochloric acid. Copper filings and powdered sulfur mixed together are only a mixture, but when the mixture is heated, it changes its character and becomes copper sulfide.

While outside agencies, as heat or light, are sometimes needed to cause these chemical reactions, this is not always the case. The more mixing of the substances may result in the formation of the compound.

From the above it will be noted that a compound is a chemical combination of two or more substances, while a mixture is only a mechanical combination; the former cannot be readily resolved into its original parts, while the mixture can.

Ionization.—When acids, bases and salts are dissolved in water the molecules of which they are composed are broken up into positive and negative elements or groups of elements, called radicles (or radicals), each carrying an electrical charge. These charged radicles are called ions. For instance, hydrogen chloride dissolved in water dissociates and the degree to which this dissociation takes place is dependent upon the concentration of the chemical in the water and on the temperature during dissociation. In a normal solution (see this text later for definition of a normal solution) of hydrochloric acid at 18°C, equilibrium is attained with 78% of the HCl dissociated. This can be expressed as:

$$\underset{22\%}{HCl} \quad \underset{78\%}{H^+ \; Cl^-}$$

This means that in a normal solution of HCl at a temperature of 18°C there is always 22% of the HCl in its original combined form and 78% in the form of positive and negative ions. This condition is not static, as the H^+ and the Cl^- are constantly combining to form HCl with no electrical charge, and part of the HCl is constantly splitting up into more H^+ and Cl^- ions. But the balance is always maintained unless the temperature or the concentration changes. Increasing the temperature increases the dissociation and vice versa; increasing the concentration decreases the dissociation. Ionization always tends to become more complete as the dilution becomes greater.

Because *only* the ions in a solution enter into a chemical reaction an acid or a base is known as strong or weak, depending on how much it is ionized in solution. The strong acids, such as hydrochloric, nitric and sulfuric, are highly ionized in solution, as are the strong bases such as sodium hydroxide and potassium hydroxide. Acetic and carbonic acids are but slightly ionized and are therefore known as weak acids.

Fig. 4—Taylor High Phosphate Slide Comparator.

When two or more acids and bases or salts are dissolved in the same solution, new compounds are formed. If the new compounds are all soluble in water, they intermingle, combine and dissociate and cannot again be separated easily. If, however, one of the compounds is a gas, CO_2 for instance, or is a substance insoluble in water (as aluminum hydroxide, commonly called alum floc) it will become chemically inactive and will leave the reaction. For example, when aluminum sulfate or alum ($Al_2(SO_4)_3$) is dissolved in water it dissociates into Al^{+++} and SO_4^{--}. If lime is present in the water as $Ca(OH)_2$, it too will dissociate into Ca^{++} and OH^-. These four ions and two salts are in one solution and contact with each other. Positive ions are attracted to the negative ions and they combine. When the Ca^{++} and the SO_4^{--} ions combine, they form $CaSO_4$ which, being soluble in water, dissociates again and continues in solution. However, when the Al^{+++} ion combines with OH^- ion, aluminum hydroxide is formed which, being insoluble in water does not again dissociate. Thus a floc is started which grows as more molecules of aluminum hydroxide form, until it is the visible floc seen in the coagulation basin. Thus two ions have combined to form a substance which no longer dissociates and which leaves the solution.

This discussion should be referred to in connection with the application of chemistry to water purification.

pH.—The term pH refers to the hydrogen-ion concentration of a liquid and is a measurement of the *intensity* of *acidity*, or its opposite, *alkalinity*. The term "alkalinity" has been used so broadly to denote both the hydrogen-ion concentration, and the amount of certain dissolved minerals in a water as to create some confusion. For example, a pH reading of 9.0 indicates that a water is alkaline, but there is no relation between a pH of 9.0 and an alkalinity of 9. In fact water may be acid by the pH scale and still contain enough dissolved minerals to have an alkalinity (see data below on alkalinity) of 100 or more p.p.m.

pH therefore is used to designate the degree by which a liquid is acid or anti-acid. pH 7.0 is neutral; figures below 7.0 indicate acidity. For instance pH 6.0 is acid, 5.0 is still more acid; and 4.0 is very acid. Above 7.0, the reverse is true; 8.0 is anti-acid (commonly called alkaline); 9.0 is more strongly anti-acid; and 11.0 very strongly anti-acid.

Alkalinity.—Alkalinity represents the amount, in parts per million of certain dissolved minerals in a liquid. These minerals are hydroxides, carbonates or bicarbonates of calcium, magnesium, potassium and sodium. There are three kinds of alkalinity, which exist in quite definite pH ranges. This particular relationship between pH and alkalinity must not lead to confusion regarding them. The types of alkalinity and the pH ranges in which they exist are: (1) Bicarbonate alkalinity, caused by compounds containing HCO_3, in the pH range below 8.3; carbonate alkalinity, caused by compounds containing CO_3, in the pH range above 8.3; and hydroxide or caustic alkalinity, caused by compounds containing OH, above pH 9.4.

Salinity.—Salinity is caused by potassium, calcium, magnesium, and sodium sulfates, chlorides and nitrates. When present in excessive amounts, salinity is objectionable in water.

How Chemicals Combine:

The principles governing the combination of elements to form compounds have already been stated briefly. The atomic and molecular weights are used for determining how much of each element is required to form the desired compound, and also as a check on computations, since both sides of an equation must balance. The procedures explained in connection with the combination of elements to make compounds apply also to the addition of compounds to produce other desired compounds. For instance if quicklime and sulfuric acid are combined, the result will be calcium sulfate and water. The chemical reactions involved are:

$$H_2SO_4 + CaO = CaSO_4 + H_2O$$

The atomic weights when shown in the following form best illustrate the method of using them:

H_2SO_4	+	CaO	=	$CaSO_4$	+	H_2O
2H = 2.02		Ca = 40.08		Ca = 40.08		2H = 2.02
S = 32.06		O = 16.00		S = 32.06		O = 16.00
4O = 64.00				4O = 64.00		
98.08	+	56.08	=	136.14	+	18.02

The atomic weights of the compounds shown in the bottom line of the above quotation totalling 154.16 on both sides of the equation indicates that it is correct. Similarly:

sulfuric acid	+	sodium hydroxide	=	sodium sulfate	+	water
H_2SO_4		2NaOH		Na_2SO_4		$2H_2O$
98.08	+	80.02	=	142.06	+	36.04

The weight ratio method shown is important in solving various problems in chemical feeding. For instance, how much sulfuric acid would be required to combine with 100 pounds of CaO, and how much gypsum (calcium sulfate) would be formed?

From the reaction above 98.08 pounds of sulfuric acid are required for combining with 56.08 pounds of CaO. Therefore, 100 pounds of CaO will require 100 x 98.08 ÷ 56.08 = 175 pounds of sulfuric acid; and this will produce 100 x 136.14 ÷ 56.08 = 243 pounds of $CaSO_4$; the remainder will be water; as shown in the equation above, amounting to 100 x 18.02 ÷ 56.08, or 32 lbs.

Water Content.—Some formulas are written thus: $FeSO_4.7H_2O$. The $FeSO_4$ indicates ferrous sulfate; the H_2O indicates that the compound is a hydrate, that is, that it contains water; and the 7 indicates the amount of water it contains. Thus the true crystal of aluminum sulfate has the formula $Al_2(SO_4)_3.18H_2O$ but aluminum sulfate is obtainable with either less or more water content. The water content is important in purchasing by weight, and also in computing dosages by weight of crystal. It is important to buy chemicals on the basis of their chemical content. Aluminum sulfate should be purchased on its content of Al_2O_3, and ferric chloride and ferrous sulfate on their iron content.

Terminology.—As already stated, the force that holds the elements together into compounds is electrical in nature; and since those elements having like electrical charges will not combine, compounds are made up of electro-positive and electro-negative elements. Hydrogen and the metals are positive; and chlorine, oxygen, etc., are negative. When joined in a compound, the name is formed by the name of the electro-positive element, followed by the name of the electro-negative, with the suffix or ending "ide," as sodium chloride (NaCl); calcium oxide (CaO); zinc sulfide (ZnS); and aluminum oxide (Al_2O_3). When two elements form more than one compound, a numerical prefix is used on the electro-negative term, as carbon monoxide (CO); carbon dioxide (CO_2); phosphorous trioxide (P_2O_3); and phosphorous pentoxide (P_2O_5).

Where elements form more than one oxide, the suffix "ous" is used to indicate the lower condition of oxidation, and the suffix "ic" to indicate the higher condition. For example, cuprous oxide (Cu_2O) and cupric oxide (CuO). The same suffixes are used in the same way with acids. Sulfurous acid (H_2SO_3) is a combination of sulfur dioxide and water; and similarly sulfuric acid (H_2SO_4) is a combination of sulfur trioxide (SO_3) and water.

The terminations "ite" and "ate" are used to indicate the salts derived from acids terminating in "ous" and "ic," as sodium sulfite (Na_2SO_3) which is derived from a combination of sodium hydroxide (NaOH) with sulfurous acid; and sodium sulfate (Na_2SO_4), which is formed by sulfuric acid and sodium hydroxide.

In some cases there are compounds still lower or higher in the series than those employing "ous" or "ic" endings. The prefix "hypo" is used to distinguish those that are lowest, and the prefix "per" those that are highest. For example, in order of oxygen content, hypochlorous, chlorous, chloric and perchloric acids; and hypochlorites, chlorites, chlorates and perchlorates.

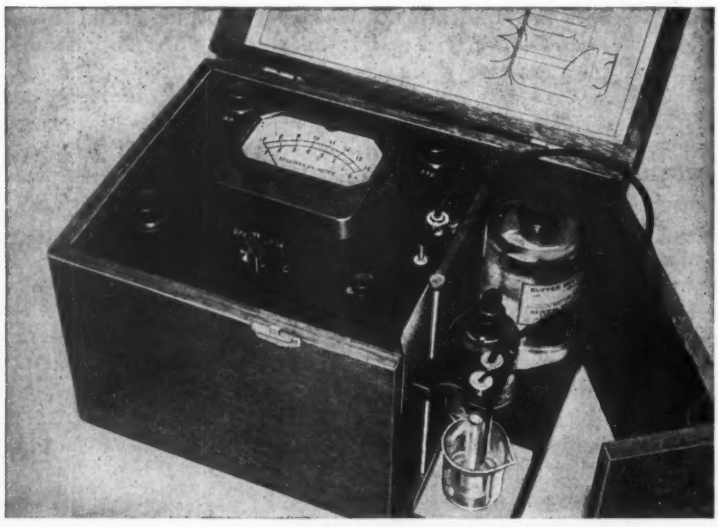
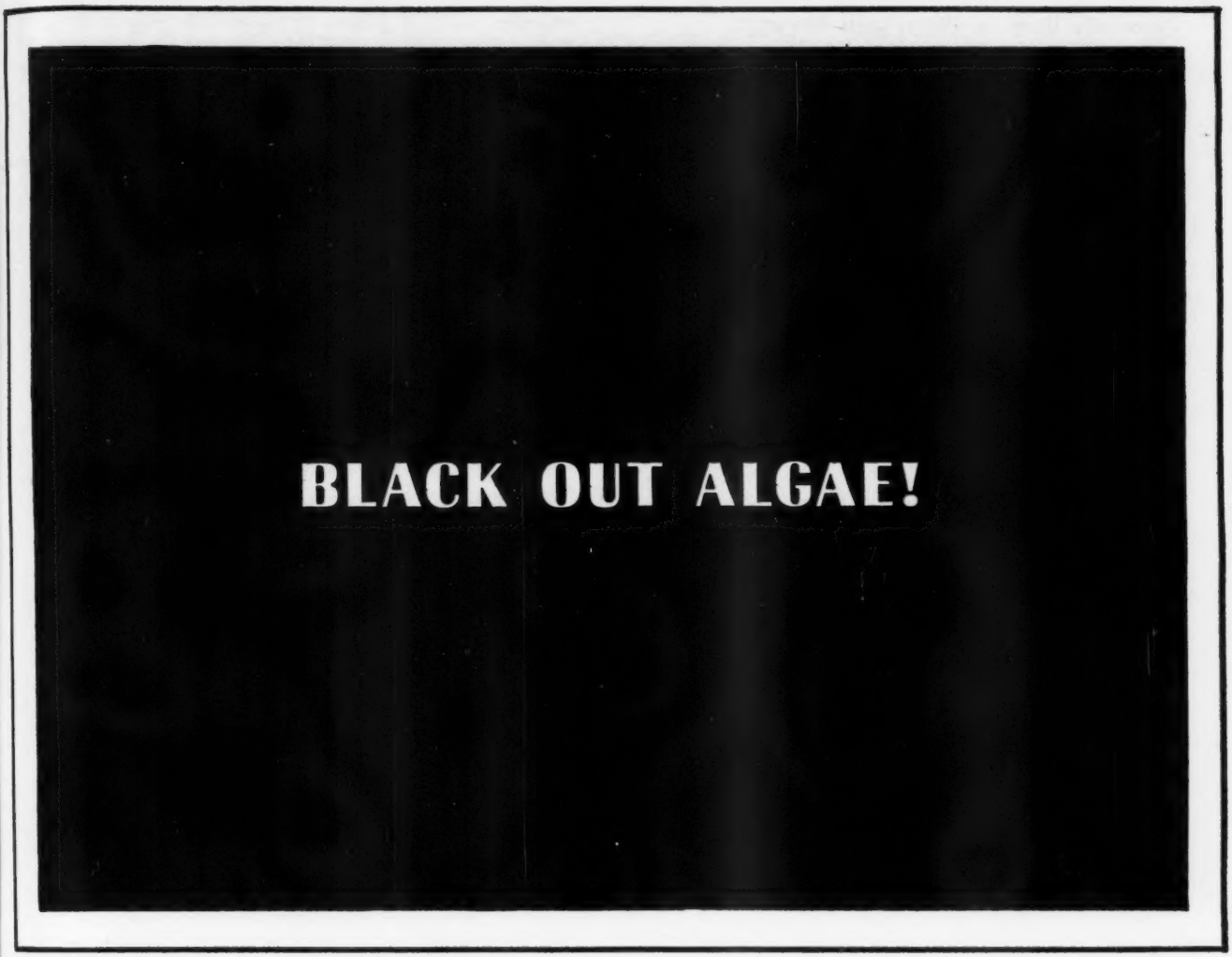


Fig. 5—Beckman pH meter, Industrial model, Nat'l Tech. Laboratories.



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Gases.—The gases used or met with in water and sewage work include:

Chlorine: Symbol Cl; specific gravity 2.49; atomic weight 35.46. Chlorine is a greenish-yellow gas which, under pressure, is converted to a liquid. Either as a gas or as a solution, it is used for killing bacteria, for checking the growth of, or killing, algae or slimes and for other purposes in water treatment. It is irritant to the lungs and membranes of the nose, throat and respiratory system, and causes violent coughing. A concentration of 1 part of chlorine in 100,000 of air can be noticed; 1 part in 50,000 parts of air causes inconvenience; and 1 part in 1,000 of air may produce death after 5 minutes exposure. It is 2.49 times heavier than air and therefore will be most dense near the floor. It combines with ammonia to form ammonium chloride, a white, cloudy gas. The test, therefore, for chlorine leaks is to hold a bottle of ammonia at valves, connections and other places where chlorine may be leaking. Gas masks are available to protect against chlorine, but masks designed for protection against other gases may not be effective against chlorine.

Oxygen: Symbol O; specific gravity 1.105; atomic weight 16.00 Oxygen is a colorless, odorless gas which combines readily with many elements to form numberless compounds, both organic and inorganic.

Hydrogen: Symbol H; specific gravity 0.07; atomic weight 1.01. Hydrogen is the lightest known material; it is a constituent in all acids, and combines with many other elements. In combination with carbon, it forms coal.

Hydrogen Sulfide: Symbol H_2S; a colorless gas, heavier than air. The odor in low concentrations is that of rotten eggs; in high concentrations, it has a sweet odor; at 1000 p.p.m. there is no odor. The maximum safe concentration without gas masks is 20 p.p.m.; 700 p.p.m. causes death in a short time; 1000 p.p.m. causes death almost instantaneously.

Nitrogen: Symbol N; specific gravity 0.97; atomic weight 14.01. Nitrogen is an odorless, colorless and tasteless gas.

Carbon dioxide: Symbol CO_2; molecular weight 44.01; carbon monoxide, symbol CO, molecular weight 28.01, an odorless, colorless, poisonous gas; and ammonia, symbol NH_3, are other familiar gases.

Acids.—Hydrochloric or muriatic acid is made by mixing H and Cl in proper proportions and exposing the mixture to a flame or bright light. The resulting gas, HCl, when absorbed in water forms hydrochloric acid. The term hydrochloric acid is frequently applied to either the gas or the solution in water, although the correct term for the gas is hydrogen chloride. HCl in solution form is clear or slightly yellow, with a pungent odor and a corrosive action. The standard grade has a specific gravity of 1.178 to 1.188 and a strength of 35% to 37%.

Nitric acid, sometimes called aqua fortis, has the formula HNO_3. It is a clear, colorless or yellow liquid, with a pungent odor and is extremely corrosive. It is subject to decomposition by sunlight, turning brown on exposure. Nitric acid, 36° Baume, contains approximately 52.3% HNO_3, but stronger concentrations are available.

Sulfuric acid, H_2SO_4, is a clear or slightly cloudy, heavy liquid with an extremely corrosive action. Specific gravity is from 1.835 to 1.840. Probably the most generally used grade is 66° Baume, which has a strength of 93.2%, but other concentrations are available. The CP (meaning chemically pure) grades are usually 95% to 96% H_2SO_4, the remainder being water, which sulfuric acid takes up readily from the atmosphere. For this reason, solutions may lose strength on standing. If water is added to concentrated sulfuric acid, violent heat is generated and there may be an explosion; therefore, the acid should always be added to the water in small quantities and carefully.

Carbonic acid, H_2CO_3, is formed by dissolving CO_2 (carbon dioxide) in water, the reaction being:

water	+	carbon dioxide	=	carbonic acid
H_2O	+	CO_2	=	H_2CO_3

H_2CO_3 is a weak acid; in fact it is used in most charged water and soft drinks. It combines readily with sodium, calcium and magnesium to form carbonates, as follows (for calcium):

$$H_2CO_3 + CaO = CaCO_3 + H_2O$$

Metals.—Calcium, symbol Ca, atomic weight 40.08, is an alkaline-earth metal or alkali. A common compound of calcium is CaO, or quicklime, which has an affinity for water which it may take up from the air; or water may be added to slake the lime. In either case, the result is hydrated lime Ca(OH). The reaction is:

lime	+	water	=	hydrated lime
CaO	+	H_2O	=	$Ca(OH)_2$

When carbon dioxide (CO_2) comes in contact with lime, it forms calcium carbonate ($CaCO_3$). When it combines with hydrated lime, it forms $CaCO_3$ and water:

$$CO_2 + Ca(OH)_2 = CaCO_3 + H_2O$$

If still more CO_2 is added, it combines with water to form H_2CO_3, and bicarbonate is formed, as follows:

$$CaCO_3 + H_2CO_3 = Ca(HCO_3)_2$$

Calcium unites with chlorine to form calcium chloride ($CaCl_2$), a chemical used for road construction, for dustlaying, for melting ice and for many industrial purposes. Calcium sulfate, $CaSO_4$, commonly called gypsum, is an important building material and is the base for plaster of paris. Calcium hypochlorite will be considered later.

Magnesium, Symbol Mg, atomic weight, 24.32, is often found in association with calcium. It enters generally into the same compounds as calcium. With calcium it is responsible for carbonate hardness in water. The so-called temporary hardness of water is due to calcium and magnesium bicarbonates, Ca $(HCO_3)_2$ and Mg $(HCO_3)_2$. When water containing these compounds is heated the carbon dioxide is driven off leaving carbonates, which are quite insoluble and can be removed by settling. For example:

Calcium bicarbonate	–	carbonic acid	=	calcium carbonate
$Ca(HCO_3)_2$	–	H_2CO_3	=	$CaCO_3$

Sodium, symbol Na, atomic weight 23.00, is an alkali metal. Perhaps its principal use in water purification is as sodium carbonate, Na_2CO_3, which is used in the same way lime is used to provide alkalinity or correct corrosiveness or an acid condition in water. Other forms are sodium sulfate (Na_2SO_4), sodium chloride or common salt (NaCl); sodium hydroxide or caustic soda (NaOH); sodium thiosulfate ($Na_2S_2O_3.5H_2O$) which is used to remove an excess of chlorine following superchlorination; sodium silicate or water glass (Na_2SiO_2 is one of several formulas) which is used for coating the inside of water pipes to prevent corrosion; sodium metasilicate ($Na_2SiO_3.5H_20$) which is sometimes used to prevent scale formation or corrosion, and sodium

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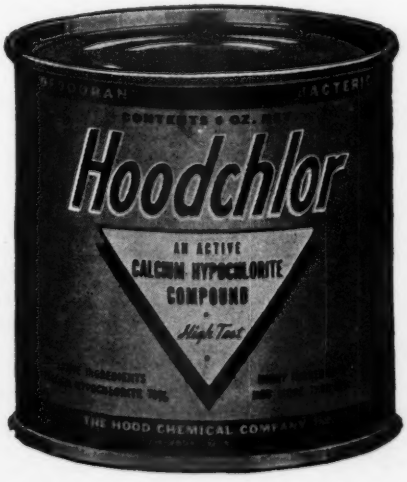

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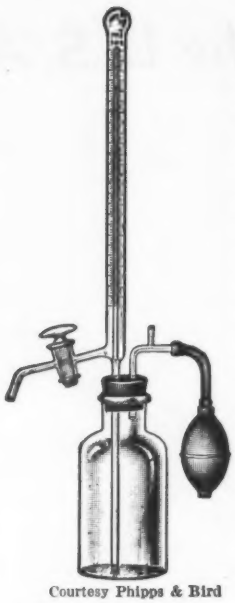

Courtesy Phipps & Bird

Fig. 6—Automatic Burette

hexametaphosphate, an inhibitor of calcium and other deposits. Potassium, symbol K, atomic weight 39.10, is an alkali metal resembling sodium in many of its characteristics.

Aluminum: Formula for aluminum sulfate, $Al_2(SO_4)_3$. Theoretically the crystal formula is $Al_2(SO_4)_3 . 18H_2O$, but as produced commercially the formula is $Al_2(SO_4)_3 . 14H_2O$. As already stated, the H_2O indicates that the compound is a hydrate (contains water) and the 14 or 18 indicates the amount of water it contains. Aluminum sulfate, which is commonly called "filter alum," is used for coagulation in both water and sewage treatment. The floc that is formed and which assists settlement by attracting and carrying down much of the suspended and some of the colloidal matter is aluminum hydroxide. The reaction in coagulation, when lime is used to supply the alkalinity necessary for reaction is:

aluminum sulfate	+	hydrated lime	=	calcium sulfate	+	aluminum hydroxide
$Al_2(SO_4)_3$	+	$3Ca(OH)_2$	=	$3CaSO_4$	+	$2Al(OH)_3$

Ammonia alum is sometimes used for coagulation, but since the cost is much more than that of aluminum sulfate, it is economical only for certain conditions, as with pressure filters and alum pots. The formula for ammonia alum which is a true alum is $Al_2(SO_4)_3 . = (NH_4)_2SO_4.24H_2O$. Ammonia alum dissolves more slowly which is an advantage for pressure filter installations. Based on the Al_2O_3 content, the cost is about three times as great as for ordinary or filter alum.

Sodium aluminate ($Na_2Al_2O_4$) is another coagulant that is advantageous for certain uses, primarily with water used for boilers or for steaming purposes. It, also, is more costly than aluminum sulfate.

The Iron Compounds.—Iron, symbol Fe, atomic weight 55.84, is used in water and sewage coagulation in a number of forms, including the following:

$FeSO_4$ ..... ferrous sulfate
$Fe_2(SO_4)_3$ ..... ferric sulfate
$FeCl_3$ ..... ferric chloride

Ferrous sulfate, frequently called copperas, should not be confused with copper sulfate which has the formula $CuSO_4$. As commonly purchased, ferrous sulfate has the formula $FeSO_4.7H_2O$. When used in coagulation, lime must usually be added to provide the alkalinity necessary for reaction, as follows:

Ferrous sulfate	+	hydrated lime	=	ferrous hydroxide	+	calcium sulfate
$FeSO_4$	+	$Ca(OH)_2$	=	$Fe(OH)_2$	+	$CaSO_4$

However, oxygen must be available to change the $Fe(OH)_2$ to $Fe(OH)_3$, which is the desired coagulant:

ferrous hydroxide	+	water	+	oxygen	=	ferric hydroxide
$4Fe(OH)_2$	+	$2H_2O$	+	O_2	=	$4Fe(OH)_3$

If chlorine is added to $FeSO_4$, ferric sulfate and ferric chloride are produced:

ferrous sulfate	+	chlorine	=	ferric sulfate	+	ferric chloride
$6FeSO_4.7H_2O$	+	$3Cl_2$	=	$2Fe_2(SO_4)_3$	+	$2FeCl_3$

It will be interesting to the student to compute how much chlorine is needed to react with each pound of ferrous sulfate in the above solution, remembering that the formula for ferrous sulfate is $FeSO_4.7H_2O$ and that an allowance must be made for the weight of the water in the hydrate. He should use the atomic weights previously given and either neglect the right half of the equation or allow for $42H_2O$ in balancing it, this being due to the $7H_2O$ contained in each unit of the $FeSO_4$.

Ferric chloride is available in lump form, the formula being $FeCl_3.6H_2O$, and also as a solution. The concentration in solution varies because of the relation between temperature and crystallization, and is about 40%, falling to 35% in cold weather. An anhydrous form is also available.

Other Chemicals.—Hypochlorites of calcium or sodium are used for various purposes, as for sterilizing newly laid mains, chlorinating small water supplies and for similar purposes. The formula for calcium hypochlorite is $Ca(ClO)_2$, and for sodium hypochlorite is NaClO. With these formulas, the molecular weight of the calcium compound is $40.08 + 70.92 + 32.00 =$ 143.00, and the chlorine content may be $70.92 \div 143$ = about 50%; for the sodium compound, the weight is $23.00 + 35.46 + 16.00 = 74.46$, and the chlorine content is $35.46 \div 74.46 =$ about 46%. Actually, ordinary forms of hypochlorite contain 25% to 30% of available chlorine; but HTH and Perchloron contain about 70%. There is great variety of hypochlorite formulas in actual use and the above are given merely as being typical forms.

Activated carbon differs from other chemicals in that its value is measured by what it accomplishes rather than its chemical analysis. The action of activated carbon is by adsorption. When activated carbons absorb impurities from solution, these impurities are actually removed rather than changed by chemical reaction from one compound to another. Activated carbon has the characteristics of removing organic compounds and occasionally inorganic compounds from solution. It is for this reason that the primary application of activated carbon in the water and sewage field is for control of odors.

Other chemicals or compounds employed or encountered in water and sewage work include the following:

NaOH, or sodium hydroxide or caustic soda, used generally as an alkali.

$CuSO_4$, copper sulfate, used in algae control.

NH_3, ammonia, found in sewage; also used with chlorine for water treatment.

NH_3Cl or $NHCl_2$, chloramine, used in water treatment.

SO_2, sulfur dioxide, used for various purposes in water treatment.

SO_3, sulfite, does not occur alone, but in combination with a base, as Na_2SO_3, sodium sulfite.

SO_4, sulfate, combines with H to form sulfuric acid, or with a base to form a salt, as $CaSO_4$, calcium sulfate.

Making Standard Solutions:

A standard solution is one that contains a known weight of the substance under consideration in a definite volume of solution. Standard solutions are an absolute necessity in making analyses, and such solutions are usually expressed in terms of the *normal* system. An 0.02N, or an N/50 solution (also called a fiftieth normal) is a solution that is one-fiftieth as strong as a normal solution. A 5N solution is five times as strong as a normal solution. To understand fully the normal system, some explanations and a few definitions are necessary.

The *gram-atomic* weight of a substance is the atomic

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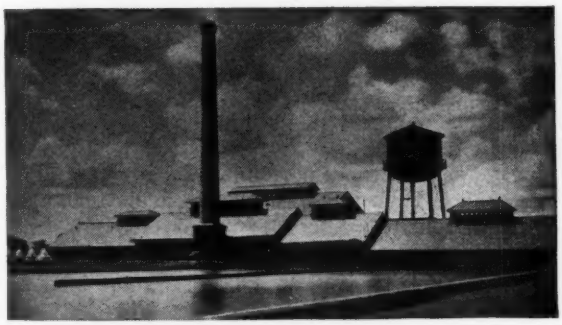

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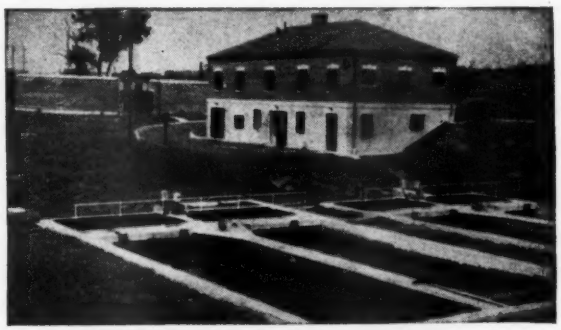

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weight of that substance expressed in grams. For example (see Table 1, atomic weights) the atomic weight of sulfur is 32.06, and the gram-atomic weight is 32.06 grams. The atomic weight of sodium is 23.00 and the gram-atomic weight is 23.00 grams.

The *gram-molecular* weight of a substance or compound is the sum of the gram atomic weights of the elements that make it up. For instance, the molecular weight of sulfuric acid, H_2SO_4, is 2.02 + 32.06 + 64.00 = 98.08, and the gram-molecular weight is 98.08 grams. The gram-molecular weight of sodium carbonate, Na_2CO_3, is 46.00 + 12.01 + 48.00 = 106.01 grams.

The *gram-equivalent* weight of a compound is computed from these. For acids, the gram-equivalent weight is the gram-molecular weight divided by the number of replaceable hydrogen atoms that they contain. For instance, H_2SO_4 contains two replaceable hydrogen atoms, and the gram equivalent weight is the gram-molecular weight divided by 2; that is, it is 98.08 ÷ 2 = — 49.04. For bases, the gram-molecular weight is divided by the number of hydrogen or hydroxyl ions entering into the neutralizing reaction. For instance, Na_2CO_3 has the equivalent of two ionizable hydrogen atoms (that is the two Na ions can be replaced by two H ions) and the gram-equivalent weight is therefore 106.01 ÷ 2 = 53.00.

The gram-equivalent weights of various compounds more or less frequently used in the water and sewerage field are shown in Table 2.

Table 2. Molecular and Gram-Equivalent Weights

	Compound	*Formula*	*Molecular Weight*	*Gram-Equivalent Weight*
1	Aluminum sulfate	$Al_2(SO_4)_8$	342.14	57.02
2	Calcium carbonate	$CaCO_3$	100.09	50.04
3	Calcium oxide	CaO	56.08	28.04
4	Calcium sulfate	$CaSO_4$	136.14	68.07
5	Ferrous sulfate	$FeSO_4$	151.90	75.95
6	Ferric chloride	$FeCl_3$	162.21	54.07
7	Hydrochloric acid	HCl	36.47	36.47
8	Hydrogen sulfide	H_2S	34.08	17.04
9	Nitric acid	HNO_3	63.02	63.02
10	Sodium carbonate	Na_2CO_3	106.01	53.00
11	Silver nitrate	$AgNO_3$	169.89	169.89
12	Sodium hydroxide	$NaOH$	40.01	40.01
13	Sulfuric acid	H_2SO_4	98.08	49.04

These gram-equivalent weights are given in most chemistry texts, or they may be computed. Considering aluminum sulfate, the molecular weight is obtained by adding the atomic weights of the elements that make it up; the number of equivalent ionizable hydrogen atoms can be determined by inspection. For instance we know that SO_4 and 2H combine to form H_2SO_4. Therefore SO_4 will combine with two hydrogen ions. In $Al_2(SO_4)_3$, the Al_2 combines with three SO_4 and therefore it must be equivalent to 6H ions. Thus the gram equivalent weight is 342.14 ÷ 6 = 57.02.

Since Ca can be replaced by H_2 (or 2H), the factor in lines (2), (3) and (4) of Table 2 is 2 and gram equivalent weights are one-half the molecular weights. In line (6), we remember that H and Cl combine, whereas Fe combines with 3Cl; therefore the gram-equivalent weight is the mloecular weight divided by 3. In lines (7), (9), (11) and (12), there is only a single H and the molecular and gram equivalent weight are the same.

Normal Solutions.—A normal solution contains one gram-equivalent weight of that substance in a liter of solution. A normal solution of sulfuric acid (see Line 13), therefore, contains 49.04 grams of pure sulfuric acid in one liter of solution; usually the pure acid is added to distilled water to make up the required quantity of one liter. Likewise a normal solution of calcium carbonate contains 50.04 grams (see Line 2) of the pure calcium carbonate in one liter of solution. A milliliter (or a liter, quart, etc.) of the sulfuric acid solution will exactly neutralize a milliliter (or liter, quart, etc.) of the calcium carbonate solution.

An 0.02N, a fiftieth normal or an N/50 solution of sulfuric acid are all the same and will contain 1/50 of 49.04 grams or 0.98 gram of pure sulfuric acid in 1 liter. In the case of calcium carbonate, one liter of an N/50 solution will contain 50.04 ÷ 50 or almost exactly 1.00 gram of pure calcium carbonate.

A tenth normal (0.10 or N/10) solution of sulfuric acid will contain 4.904 grams of pure acid in a liter of solution; a normal solution, as already stated, will contain 49.04 grams; a 10N solution will contain 490.4 grams, etc.

The preparation of these normal solutions must begin with some material that can be obtained in a pure state; sodium carbonate is usually employed initially. A solution of normal or less than normal strength is obtained by weighing out the required amount, and this is diluted as desired. From this standard solution, sulfuric acid and other solutions are made up by checking against the original. The procedure requires some practice and skill in handling chemicals and chemical equipment. A particularly clear description of the detail procedure to be followed is given in Theroux, Eldridge & Mallman's book. It is better for the small sewage or water plant laboratory without a trained chemist to purchase solutions of definite strength already made up.

Solutions may change in strength as times passes, and they should be checked by titrating them against solutions of known strength, and their variation from normal determined and corrected for in subsequent calculations. Titration means adding measured small quantities of the standard until a definite end-point is shown. In actual laboratory practice, solutions are not always kept at exact normal strength, but their actual strength is known and allowances made for this in the computations.

Molar Solutions.—A molar solution of a substance is a solution that contains one gram-molecular weight of the substance in one liter of solution. As already stated, the gram-molecular weight is the sum of the gram-atomic weights of the elements that make up the command. Molar solutions are indicated by strength in the same way that normal solutions are indicated; that is, 0.01M or M/100; M/50; 10M, etc.

An Ml solution, that is a molar solution, of sulfuric acid contains 98.08 grams of the pure acid in one liter; an 0.02M solution (M/50 solution) contains 1.9616 grams; and an 0.01M (M/100) solution contains 0.98 gram, or exactly the same as an N/50 solution. In the case of H_2SO_4, Na_2CO_3 and other compounds that have two replaceable hydrogen atoms, the Molar solution is twice as strong as the Normal solution, and an M solution equals a 2N solution. In the case of those compounds that have but one replaceable hydrogen atom, as HNO_3, HCl and NaOH, the gram equivalent weight is the same as the gram molecular weight, and the Molar and Normal solutions are of equal strength.

Chemical Tests.—It is not the purpose of this text

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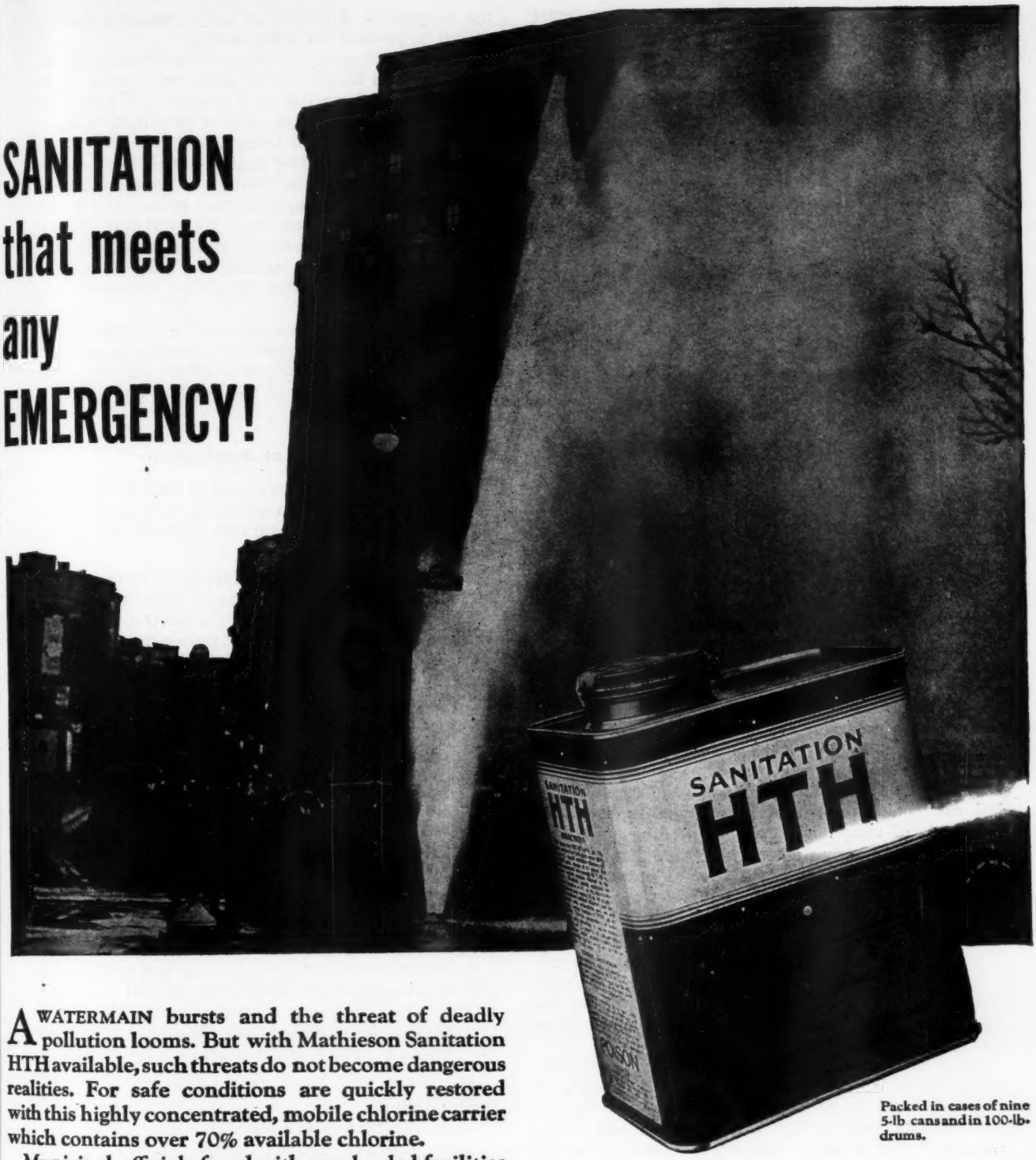

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Fig. 7—Taylor Water Analyzer Case.

to explain the procedure in making chemical tests, for which "Standard Methods" or the excellent text by Theroux, Eldridge and Mallman should be followed, but it is desirable to be familiar with the various terms used in connection with them. General methods employed in testing include qualitative analyses, which are made to determine what elements or compounds are present, and quantitative analyses which are made to determine the amounts present.

Before attempting to determine the amount of chemical compounds present, it is necessary to determine the kinds of compounds that are in the sample. In many cases, a quantative analysis is all that is necessary, but in other cases it will serve as a guide to the methods to be employed for further testing. A very simple form of qualitative analysis is the addition of orthotolidine solution to water to determine if chlorine is present. The presence of color indicates that chlorine is present; and, as a matter of fact, this test is quantitative also, since the intensity of color indicates the amount of chlorine in the water; and the method of analysis is colorimetric.

Gravimetric quantitative analyses are made by weighing the amount of compound that is present in the sample, the compound first being charged by appropriate methods so that it is insoluble and easily separated. For example, the determination of sulfur in a sample of sewage involves changing the sulfur to sulfate and combining it with a soluble salt of lead or barium. The resulting compound is insoluble and can be removed by filtration and weighed, permitting the amount of sulfur in the original sample to be calculated.

Volumetric quantitative analyses are made by adding a chemical of known concentration or strength to an exact quantity of the sample. The volume of the reagent required for the desired reaction permits the amount of chemical in the sample to be calculated. For example, the alkalinity of water is determined by adding to a sample of 100 ml. (after phenolphthalein or methyl orange indicator has been added) N/50 sulfuric acid until a color change is noted. The alkalinity of the water, expressed in parts per million, is 10 times the number of milliliters of N/50 sulfuric acid required to produce the color change.

Colorimetric quantitative analyses involve the determination of the amount of unknown chemical in the sample by matching the color produced by adding the same chemical to a set of samples containing a known amount of the chemical being tested for, or by artificial color standards. This method is valuable in determining the presence and amounts of minute quantities of chemicals. For example, nitrites in water or sewage can be determined by adding a chemical that produces a distinct color in the sample; and matching this color with that produced by adding the same chemical to previously prepared tubes containing known amounts of nitrates.

Turbidimetric analyses are used in determining the amount of turbidity present in a sample by matching it with a series of suspensions of known turbidity. This is illustrated in the use of the familiar turbidity samples.

Methods of Application

In water treatment, chemistry is used in the determination of alkalinity, in softening, in coagulation, in corrosion control and in various fields of water treatment.

Alkalinity, salinity and hardness are caused by the presence of certain chemical compounds in the water. A determination of certain of the kinds and amounts of these may be necessary for proper treatment procedures. Compounds that cause alkalinity, hardness and salinity may be grouped as follows:

(A) Those that cause alkalinity only:

Potassium carbonate, K_2CO_3
Potassium bicarbonate, $KHCO_3$
Sodium carbonate, Na_2CO_3
Sodium bicarbonate, $NaHCO_3$

(B) Those that cause both alkalinity and carbonate hardness:

Calcium carbonate, $CaCO_3$
Calcium bicarbonate, $Ca(HCO_3)_2$
Magnesium carbonate, $MgCO_3$
Magnesium bicarbonate, $Mg(HCO_3)_2$

It will be noted that the potassium and sodium compounds do not cause hardness, but that all carbonates and bicarbonates cause alkalinity, while all calcium and magnesium compounds cause hardness, whether in the carbonate, bicarbonate, sulfate or chloride form.

(C) Those that cause both salinity and non-carbonate hardness:

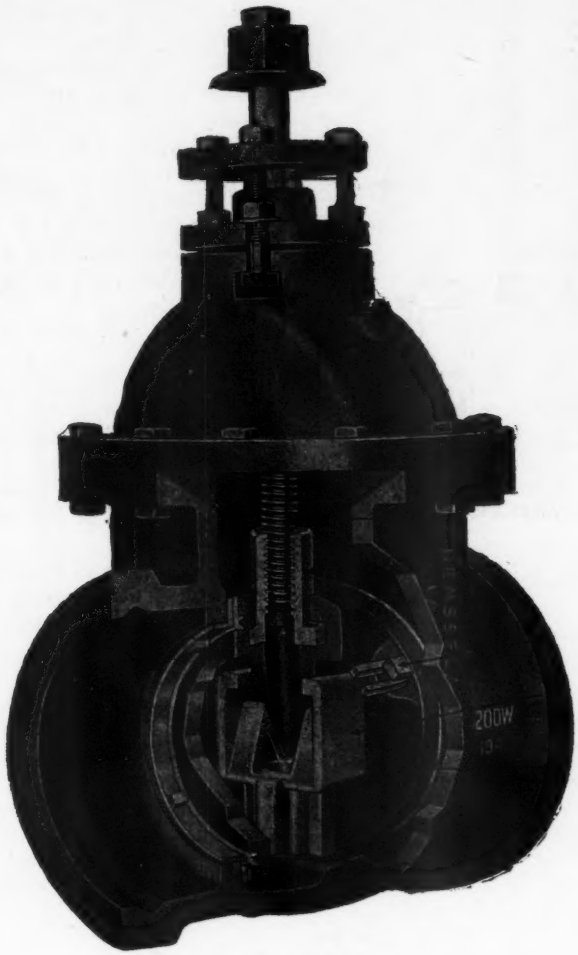
Calcium sulfate, $CaSO_4$
Calcium chloride, $CaCl_2$
Magnesium sulfate, $MgSO_4$
Magnesium chloride, $MgCl_2$

(D) Other salts that cause salinity, but not hardness:

Potassium sulfate, K_2SO_4
Potassium chloride, KCl
Potassium nitrate, KNO_3
Sodium sulfate, Na_2SO_4
Sodium chloride, $NaCl$
Sodium nitrate, $NaNO_3$

Caustic alkalinity occurs when there is an excess of lime in the water and this excess may precipitate in the distribution system or on the sand of a filter bed as $CaCO_3$. Caustic alkalinity does not occur in a natural water.

Acidity in water is caused by free CO_2, by mineral



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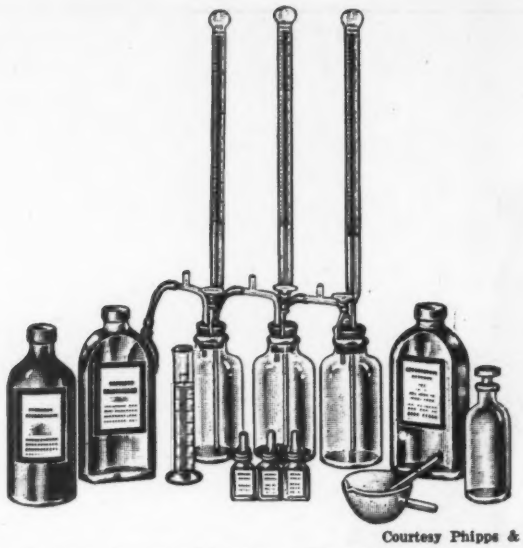

Courtesy Phipps & Bird

Fig. 8—Determination of Hardness, Alkalinities and Chlorides.

acids, by iron or aluminum sulfates and by some other less common compounds.

The basic tests for alkalinity are those for phenolphthalein alkalinity and for methyl orange alkalinity. The method of performing these tests will not be described here as there are a number of excellent texts available describing the procedures in detail.

The phenolphthalein and methyl orange alkalinity determinations show the kinds of alkalinity that are present in the water. Phenolphthalein measures none of the bicarbonates, half of the normal carbonate and all of the hydroxide alkalinity; and methyl orange measures the total of all alkalinity. All alkalinity is measured in terms of $CaCO_3$. The relationships between these three kinds of alkalinity are shown in the following examples:

(1) If the alkalinity to phenolphthalein is 0, that is, there is no color reaction to the addition of the phenolphthalein indicator solution, there is no caustic alkalinity and no carbonate alkalinity, but the alkalinity to methyl orange as shown by the test represents the bicarbonate alkalinity.

Example: Alkalinity to phenolphthalein is 0.0 p.p.m.; and to methyl orange is 18.5 p.p.m. Caustic alkalinity is 0; carbonate alkalinity is 0; and bicarbonate alkalinity is 18.5 p.p.m.

(2) When the alkalinity to phenolphthalein is less than one-half the alkalinity to methyl orange, there is no caustic alkalinity; the carbonate alkalinity is twice the phenolphthalein alkalinity; and the bicarbonate alkalinity is the methyl orange alkalinity minus twice the phenolphthalein alkalinity.

Example: Alkalinity to phenolphthalein is 28.0 p.p.m.; and to methyl orange 86.0 p.p.m. Caustic alkalinity is 0; carbonate alkalinity is 56.0 p.p.m. and bicarbonate alkalinity is 86 — (2 x 28) = 30 p.p.m.

(3) When the phenolphthalein alkalinity is exactly one-half of the methyl orange alkalinity, the caustic alkalinity is 0, the carbonate alkalinity is the same as the methyl orange alkalinity, and the bicarbonate alkalinity is 0.

Example: Phenolphthalein alkalinity is 72.0 p.p.m. and methyl orange alkalinity is 144.0 p.p.m. The caustic alkalinity is 0.0 p.p.m.; the carbonate alkalinity is 144.0 p.p.m.; and the bicarbonate alkalinity is 0.0 p.p.m.

(4) When the phenolphthalein alkalinity is more than one-half of the methyl orange alkalinity, caustic alkalinity is twice the phenolphthalein alkalinity minus the methyl orange alkalinity; the carbonate alkalinity is twice the difference between the methyl orange and phenolphthalein alkalinities; and the bicarbonate alkalinity is 0.

Example: The phenolphthalein alkalinity is 150 p.p.m.; the methyl orange alkalinity is 196 p.p.m. The caustic alkalinity is 2 x 150 — 196 = 104 p.p.m.; the carbonate alkalinity 2 x (196 — 150) = 92 p.p.m.; bicarbonate alkalinity is 0.

(5) When the phenolphthalein and methyl orange alkalinities are the same, all the alkalinity is caustic alkalinity and carbonate and bicarbonate alkalinities are 0.

Example: Phenolphthalein alkalinity is 120; alkalinity to methyl orange is 120. Hydroxide alkalinity is 120, and carbonate and bicarbonate alkalinities are 0.

The utility and method of use of alkalinity determinations will be indicated in material presented hereafter.

Hardness is of two kinds, carbonate hardness, sometimes called temporary hardness because part of it is removable by boiling; and non-carbonate hardness, also called permanent hardness because it is not affected by boiling. Carbonate hardness, as already stated, is due to calcium and magnesium carbonates and bicarbonates; the calcium carbonate is insoluble except for a residual of between one and two grains per gallon, so that partial softening is obtained by changing these bicarbonates to carbonates. Non-carbonate hardness is caused by calcium and magnesium sulfates and chlorides, also as previously stated.

Water Softening.—There are two principal methods

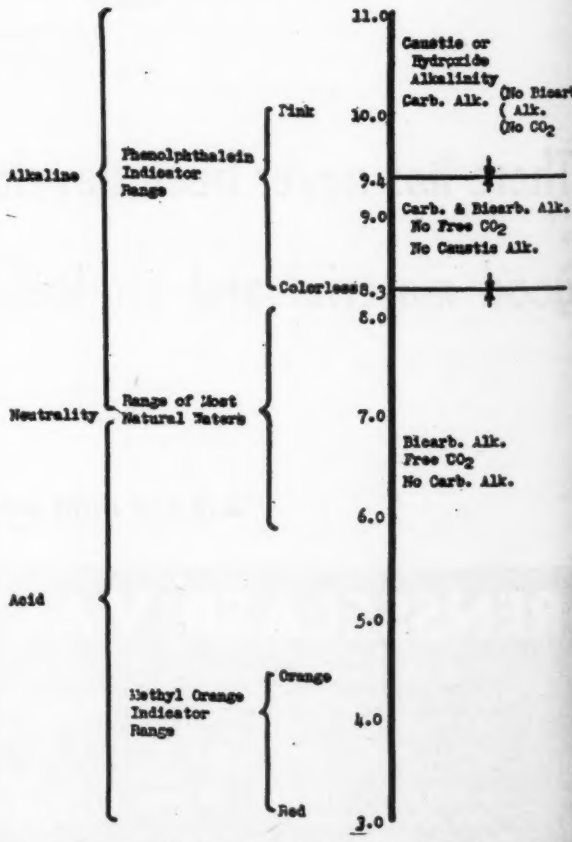

Fig. 9—Calc Carb least soluble at pH 9.4—13 ppm in solution. Mg Hydrox least soluble at pH 10.6—3 ppm $MgOH_2$ in solution.

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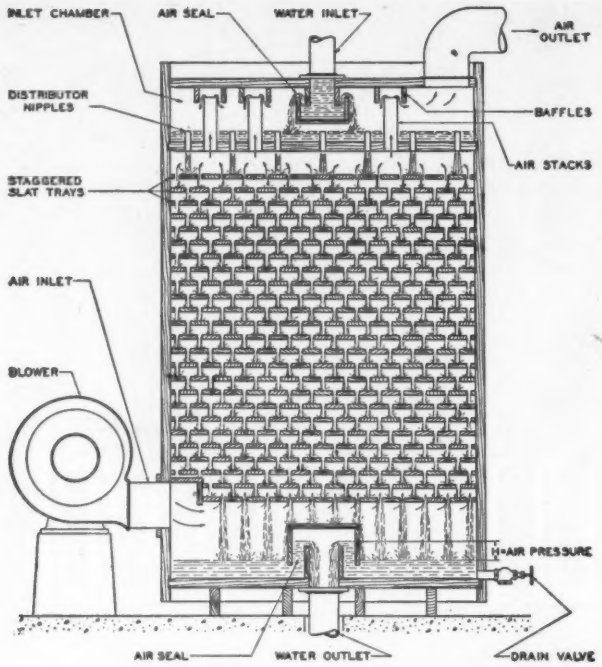

Fig. 10—Permutit Co. Degasifier.

of water softening—the lime or lime-soda process and the use of zeolites. These will be discussed separately and only from the viewpoint of the elementary chemical procedures involved. As a basis for lime-soda softening, certain tests are necessary.

A test for total hardness is necessary to measure the amount of calcium and magnesium compounds, which include those causing carbonate as well as non-carbonate hardness. That is, total hardness tests will show the amounts of the compounds listed under (B) and (C) on page 46.

The test for hardness, with the analyses for phenolphthalein and methyl orange alkalinity, permit the computation of many other factors showing information on the characteristics of the water.

When total hardness and alkalinity are the same, calcium and magnesium bicarbonates and carbonates produce all of the hardness, which is carbonate hardness. Example: Alkalinity to methyl orange 60; total hardness 60. All hardness is due to the compounds of calcium and magnesium listed under (B) on page 46.

When total hardness exceeds alkalinity, the hardness is made up of the carbonate hardness, which equals the alkalinity, and the non-carbonate hardness which equals the total hardness less the alkalinity. Example: Total hardness 80; alkalinity 60; non-carbonate hardness is 80 — 60 = 20; carbonate hardness is 60. In this case, the compounds listed under (B) and (C) preceding.

When the total hardness is less than the alkalinity, there is no non-carbonate hardness, and the difference between the total hardness and alkalinity measures the amount of sodium and potassium carbonates that are present. Example: Total hardness 60; alkalinity 80. All of the hardness is carbonate hardness [(B) page 46]; and there are 80 — 60 = 20 parts of sodium and potassium carbonates and bicarbonates [(A) page 46].

In water softening, these sodium and potassium carbonates and bicarbonates can be neglected, as they do not affect hardness. In analyses, these are stated as negative non-carbonate hardness and are subtracted from the alkalinity to show total hardness.

Reactions in Softening.—As already stated, the carbonate hardness is due to the presence of calcium and magnesium bicarbonates and carbonates, but the calcium carbonate is only slightly soluble in water—to the extent of about 20 to 30 p.p.m. In excess of this amount, the carbonates are insoluble and will precipitate or settle out. Therefore, by changing the bicarbonates to carbonates, carbonate hardness can be reduced to about 30 p.p.m.

This can be accomplished by adding lime which combines with the CO_2 in the bicarbonates and converts them to normal carbonates. The reaction for calcium bicarbonates when hydrated lime is added is as follows:

calcium bicarbonate	+	hydrated lime	=	calcium carbonate	+	water
$Ca(HCO_3)_2$	+	$Ca(OH)_2$	=	$2CaCO_3$	+	$2H_2O$

The reaction with magnesium is the same, but since $MgCO_3$ is soluble, it is converted to $Mg(OH)_2$ by the addition of more lime. This addition of an excess of lime produces caustic akalinity; and when magnesium is present forms magnesium hydroxide, which precipitates in large white flakes. The reaction is: $MgCO_3 + Ca(OH)_2 = Mg(OH)_2 + CaCO_3$.

The non-carbonate hardness ($CaSO_4$) can be removed by adding soda ash (Na_2CO_3), as follows:

$CaSO_4 + Na_2CO_3 = CaCo_3 + Na_2SO_4$.

When using lime, consideration must be given to the CaO content. The atomic weight of Ca is 40.08 and of O is 16, and the total molecular weight of CaO is therefore 56.08. Hydrated lime consists of CaO and H_2O, and is therefore $Ca(OH)_2$; the molecular weight is 40.08 + 2.02 + 32.00, or 74.10. On the basis of effective CaO, therefore, hydrated lime is by weight equal to 56.08 ÷ 74.10 = 75.7% of CaO.

In lime softening computations, analyses are required to show the free CO_2, the half-bound CO_2, the non-carbonate hardness and the total magnesium. Lime must be added to react with all of these. Half-bound CO_2 equals 44% of the alkalinity, as follows: The atomic weight of $CaCO_3$ is 100.09, and of CO_2 is 44.01, which is 44% of the weight of $CaCO_3$.

The amount of lime theoretically required to react with CO_2 is determined by adding together the free CO_2 and the half-bound CO_2, both expressed in parts per million and multiplying by a factor which is determined as follows: The atomic weight of $CaCO_3$, which is the compound into which it is desired to convert the CO_2 by the adition of lime, is 40.08 + 12.01 + 48.00 = 100.09, of which the weight of CO_2 is 44.01, and of CaO is 56.08. For each part per million of CO_2 present, there will be required 56.08 ÷ 44.01 = 1.272 parts of CaO. Since 1 p.p.m. equals 8.34 pounds per million gallons, 8.34 x 1.272 = 10.6 pounds of lime for each part per million of CO_2, whether free or half-bound, per million gallons of water. (These data are for lime with 100% CaO.)

Soda ash is required to remove non-carbonate hardness, which it does by converting the calcium sulfates and chlorides to calcium carbonates and sodium sulfates and chlorides. Since the non-carbonate hardness is expressed by the tests as parts per million of $CaCO_3$, for each p.p.m. of non-carbonate hardness, there will be required 46 + 12.01 + 48 = 106.01 (the atomic weight of Na_2CO_3) divided by 100.09 (the atomic weight of $CaCO_3$), or 106.01 ÷ 100.09 x 8.34 = 8.84 pounds per million gallons for each part per million of non-carbonate hardness.

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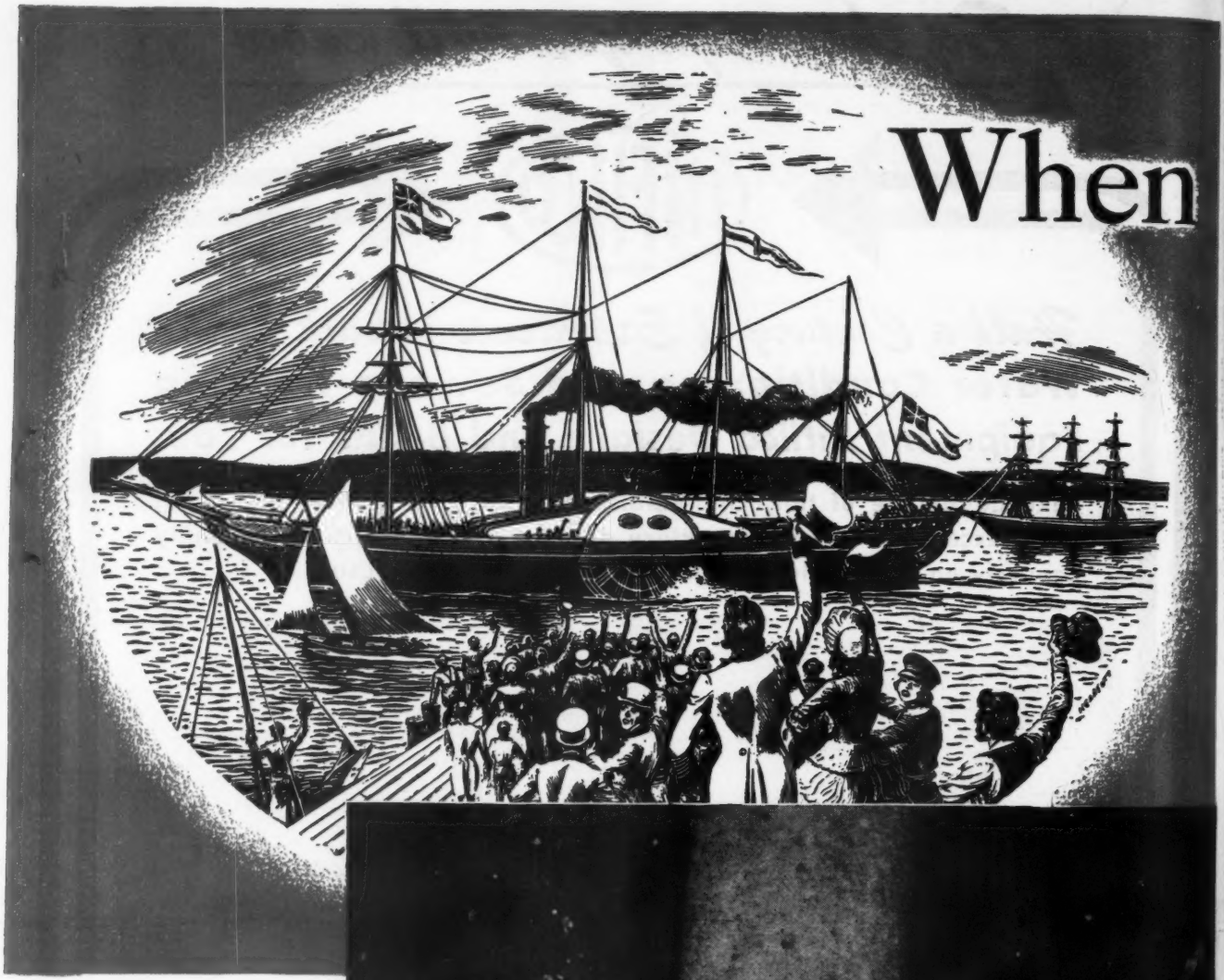

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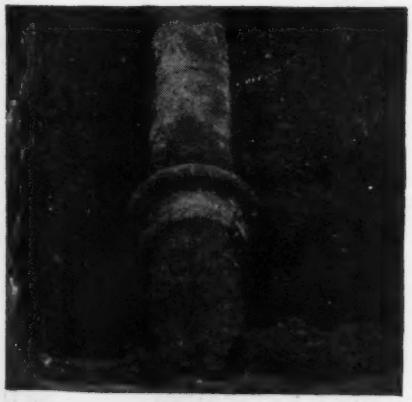

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The removal of magnesium is accomplished by adding lime. The analysis should show the total magnesium present. This magnesium, which is in the form of chlorides, carbonates or sulfates, must be changed by the addition of lime to magnesium hydroxide ($Mg(OH)_2$). The reactions are:

$$MgCl_2 + Ca(OH)_2 = CaCl_2 + Mg(OH)_2$$
$$MgCO_3 + Ca(OH)_2 = CaCO_3 + Mg(OH)_2$$
$$MgSO_4 + Ca(OH)_2 = CaSO_4 + Mg(OH)_2$$

The $Ca(OH)_2$ is, of course, hydrated lime, that is $CaO + H_2O$, but computations are on the basis of CaO.

Since the analyses show the magnesium present in any of the above forms, the amount of lime required is as the atomic weight of CaO and Mg, or 56.08 and 24.32; and for each part per million of Mg there will be required 56.08 ÷ 24.32 = 2.306 p.p.m. of lime, or 2,306 x 8.34 = 19.23 pounds per million gallons. If there are 20 p.p.m. of total magnesium, 20 x 19.23 = 384.6 pounds of lime will be required per million gallons.

Example: The analyses of a water shows the following: Free CO_2, 2 p.p.m.; alkalinity 60 p.p.m.; non-carbonate hardness 55 p.p.m.; total magnesium 12 p.p.m. To determine the amount of chemicals required for treatment:

The first decision to be made is the amount of hardness to be removed. It is not generally desirable to remove all of the hardness; assuming that it is desired to remove all but about 35 p.p.m. of non-carbonate hardness, non-carbonate hardness to be removed is 55 — 35 = 20 p.p.m.

Lime will be used as follows: To neutralize CO_2, free and half-bound, 2 + (60 x .44) = 28.4 p.p.m. x 10.6 = 301.1 pounds per million gallons. To react with and remove the magnesium, 12 x 19.23 = 231 pounds per mg. Total lime required per million gallons = 301 + 231 = 532.

Soda ash required amounts to 20 x 8.84 = 176.8 pounds per million gallons.

If alum is used for coagulant, additional soda ash or lime may be required, as shown later.

The above computations are on the basis of 100% CaO lime and 100% $NaCO_3$. Corrections must be made for lower purities or contents.

The $CaCO_3$ resulting from the addition of lime settles best at pH 9.4, whereas the Mg $(OH)_2$ settles best at pH 10.6. For most effective removal of hardness, therefore enough lime is added to produce the magnesium floc at pH 10.6. After settling, CO_2 is added by a recarbonation process to reduce the pH to 9.4 at which point the calcium carbonate settles best. In order to deliver a water that will not deposit $CaCO_3$, further recarbonation is utilized to reduce the pH to 8.7 or lower.

The results obtained by these computations are subject, in actual practice, to variations and the theoretical computed dosage may not be exactly that actually needed. It is always desirable to check the calculated amounts of chemicals by means of jar tests, using one liter, a quart or a gallon of water and noting results.

Zeolite Softening. — Zeolites are hydrous silicates of sodium and aluminum, which have the ability of absorbing calcium and magnesium (the hardness-causing elements) from water while releasing or exchanging an equal amount of sodium. The softening reaction, using Z for the zeolite compound is:

sodium zeolite + calcium bicarbonate = calcium zeolite + sodium bicarbonate, or

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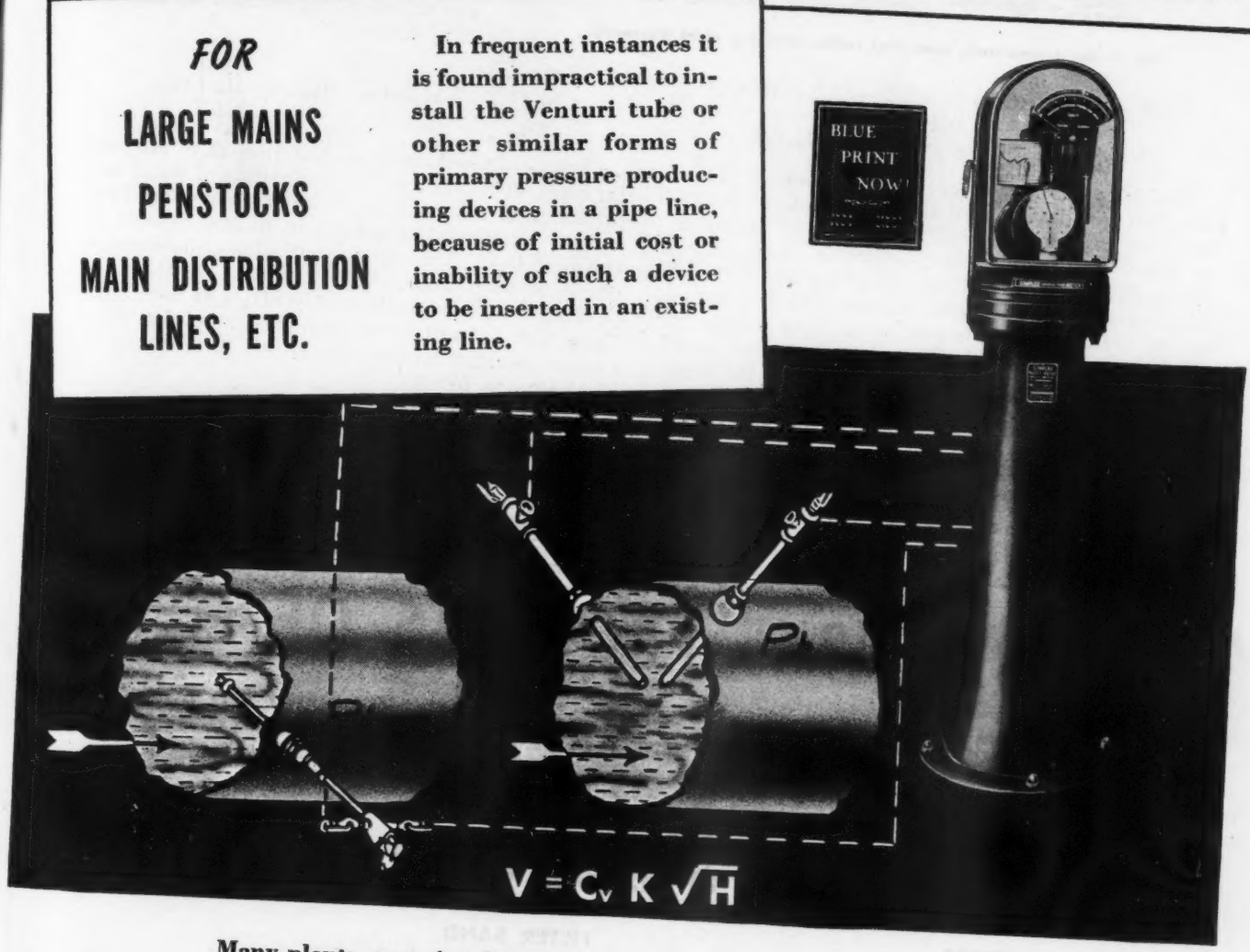

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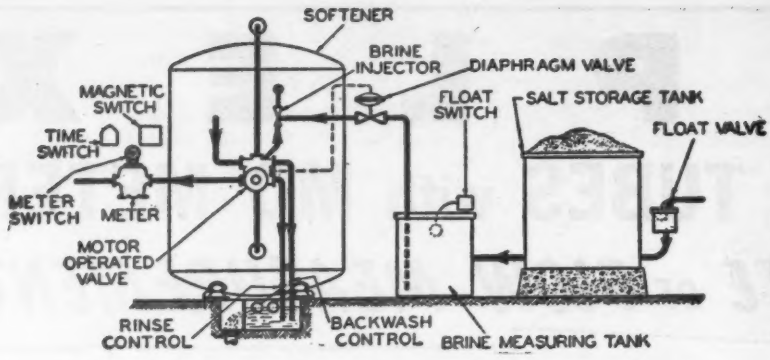

Fig. 11—An automatically controlled zeolite softening plant (Permutit).

$$Na_2Z + Ca(HCO_3)_2 = CaZ + 2\,Na(HCO_3)$$
and
$$Na_2Z + CaSO_4 = CaZ + 2\,Na_2SO_4$$

The same reaction occurs with magnesium. These materials are drawn from the water and sodium bicarbonate is returned. When the capacity of the zeolite to absorb calcium and magnesium is exhausted, a strong salt solution is passed through the zeolite, which then exchanges the absorbed calcium and magnesium for the sodium, after this process has been completed, the zeolite will again absorb the original quantity of calcium and magnesium. The reaction with the brine is:

Calcium zeolite	+	sodium chloride	=	sodium zeolite	+	calcium chloride
CaZ	+	2NaCl	=	Na_2Z	+	$CaCl_2$

Carbonaceous zeolites remove sodium, magnesium and calcium, replacing these with hydrogen. In conjunction with ordinary zeolites, the carbonaceous zeolites control the alkalinity of the water. Reactions are, using Z for the zeolite:

$$Ca(HCO_3)_2 + H_2Z = CaZ + 2H_2CO_3$$
$$Mg(HCO_3)_2 + H_2Z = MgZ + 2H_2CO_3$$
$$Na_2(HCO_3)_2 + H_2Z = Na_2Z + 2H_2CO_3$$
$$CaSO_4 + H_2Z = CaZ + H_2SO_4$$
$$MgSO_4 + H_2Z = MgZ + H_2SO_4$$
$$Na_2SO_4 + H_2Z = Na_2Z + H_2SO_4$$

The zeolite is regenerated by sulfuric acid as follows:

$$\left.\begin{matrix}Ca\\Mg\\Na_2\end{matrix}\right\} Z + H_2SO_4 = H_2Z + \left.\begin{matrix}Ca\\Mg\\Na_2\end{matrix}\right\} SO_4$$

Coagulation.—Aluminum and iron salts are used for coagulation. Data on the coagulation of water were presented in full in PUBLIC WORKS for June, 1942, and on coagulation of sewage in PUBLIC WORKS for October, 1942. This article will stress the chemical phases of coagulation.

When aluminum sulfate, $Al_2(SO_4)_3$ is used, alkalinity must be available to form the desired floc. When calcium bicarbonate, $Ca(HCO)_2$ is used to supply the alkalinity, as follows:

$$Al_2(SO_4)_3 + 3\,Ca(HCO_3)_2$$

the following compounds are produced:

$$3\,CaSO_4 + 2\,Al(OH)_3 + 6\,CO_2.$$

It will be noted that three Ca units are necessary

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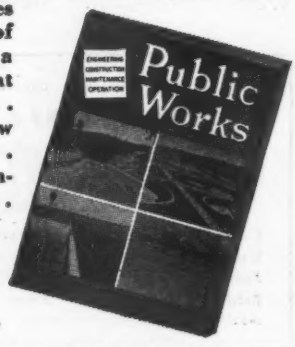

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to combine with the three (SO_4) units; and that the six HCO_3 units break down into six CO_2 and two $(OH)_3$ units. In the 3 $ca(HCO_3)_2$, there are six H, six C and eighteen O. In the six CO_2 units there are six C and twelve O; in the $(OH)_3$ units there are 60 and 6 H. Thus the equations balance.

Theoretically, for complete reaction, 7.7 p.p.m. of alkalinity are required for each grain per gallon of aluminum sulfate. This theoretical figure is based on using calcium carbonate for supplying the alkalinity. If 3 $CaCO_3$ is substituted in the above equation for 3 $Ca(HCO_3)_2$, by atomic weights, remembering that aluminum sulfate has a theoretical formula of $Al_2(SO_4)_3.18H_2O$.

Al,	atomic weight 26.97 x 2	= 53.94
SO_4,	atomic weight 96.06 x 3	= 288.18
H_2O,	atomic weight 18.01 x 18	= 324.18
Total weight $Al_2(SO_4)_3.18H_2O$		= 666.30
Ca,	atomic weight 40.08 x 3	= 120.24
C,	atomic weight 12.01 x 3	= 36.03
O_3,	atomic weight 48 x 3	= 144.00
Total weight $CaCO_3$		= 300.27

The relation of 666.30 to 300.27 indicates that 300.27 ÷ 666.30, or 45% as much $CaCO_3$ will be required as $Al_2(SO_4)_3$. The equivalent of 1 g.p.g. is 17.1 p.p.m., and 45% of 17.1 p.p.m. is 7.7 p.p.m. This is the theoretical alkalinity required; actually, the amount may vary from 6 to 10 p.p.m. When lime (CaO), hydrated lime [$Ca(OH_2)$], or soda ash (Na_2CO_3) is used, computations should be made as above. Also, allowance should be made to permit an excess alkalinity of at least 20 to 25 p.p.m. in the treated water to prevent corrosion. Step-by-step procedures for determining alkalinity requirements, and computing chemical dosages were published in this magazine June, 1942, title "Operation of Water Treatment Plants." These procedures covered (a) preparation of solutions, (b) establishing dosages of coagulants for alkaline waters and for waters deficient in alkalinity, and (c) the prevention of corrosion.

Ferric sulfate has the formula $Fe_2(SO_4)_3.9H_2O$. Alkalinity is required for the coagulation reaction, and if the water or sewage does not contain enough alkalinity, it must be supplied by lime or soda ash. When hydrated lime is added:

$$Fe_2(SO_4)_3.9H_2O + 3\ Ca(OH)_2$$

there are produced:

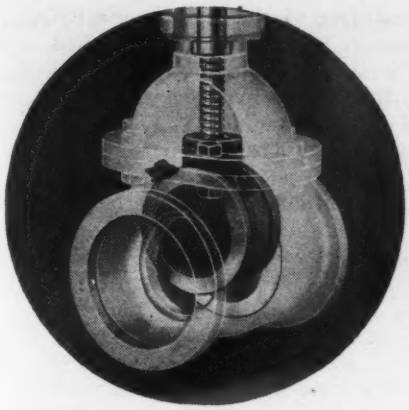
$$3\ CaSO_4 + 2\ Fe(OH)_3$$

calcium sulfate + ferric hydroxide

In practice, the alkalinity of the water should be determined by appropriate tests, and any deficiency supplied by adding lime or soda ash. To determine the amount of lime to be added, proceed as follows:

H_2O,	atomic weight 18.02 x 9	= 162.18
Fe,	atomic weight 55.84 x 2	= 111.68
SO_4,	atomic weight 96.06 x 3	= 288.18
Total weight $Fe_2(SO_4)_3$		562.04
Ca,	atomic weight 40.08 x 3	= 120.24
$(OH)_2$,	atomic weight 34.02 x 3	= 102.06
Total weight of lime $Ca(OH)_2$		222.30

If there is no alkalinity in the water, 222.3 pounds of hydrated lime will be required for each 562.04



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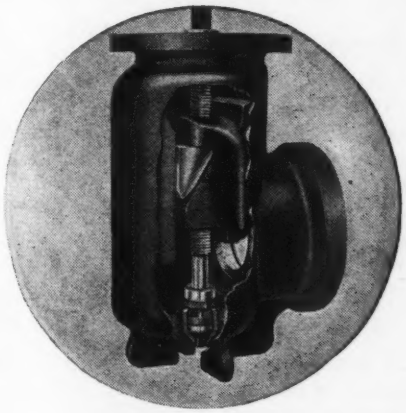

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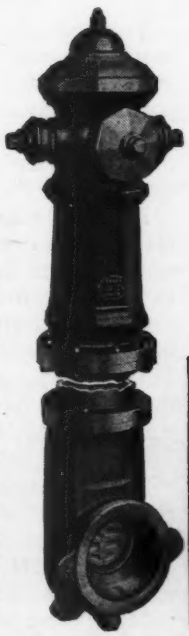

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pounds of ferric sulfate of the formula $Fe_2(SO_4)_3 \cdot 9H_2O$. If the amount of ferric sulfate applied is 1 grain per gallon, or 142.9 pounds per million gallons, the amount of hydrated lime required will be 222.3 x (142.9 ÷ 562.04) = 56.5 pounds of 100% hydrated lime. If the lime is 95% pure, about 60 pounds will be required.

It is perhaps more often the case that some alkalinity is present in the water, but not enough for the reaction to take place. Assuming that there are 5 p.p.m. of natural alkalinity as $CaCO_3$ in the water, the reaction with ferric sulfate will be incomplete.

For reaction, the ferric sulfate will require 3 x (40.08 + 12.01 + 48.00) = 300.27 pounds of calcium carbonate for each 562.04 pounds of ferric sulfate. For a dosage of 1 g.p.g., there will be required 300.27 (142.9 ÷ 462.04) = 76.2 pounds per million gallons. If there are 5 p.p.m. of natural alkalinity available in the water, this amounts to 5 x 8.34 = 41.7 pounds, and only 76.2 — 41.7 = 34.5 pounds per million gallons of alkalinity must be added. The relation, by atomic weights, between calcium carbonate and hydrated lime is 100.09:74.01, and there will be required 34.5 ÷ .74 = 46.6 pounds of hydrated lime per million gallons. In practice, as already stated, some excess alkalinity is desirable; also many factors, as temperature, mixing, etc., affect the reaction; and computations cannot be made as closely as the theoretical problem given. Probably a residual alkalinity of 20 to 25 p.p.m. would be desirable and the dosage of lime would be increased accordingly.

Ferric chloride, $FeCl_3$, is also used for coagulation. When hydrated lime is added to supply alkalinity,

$$2\,FeCl_3 + 3\,Ca(OH)_2$$

there are produced ferric hydroxide and calcium chloride,

$$2\,Fe(OH)_3 + 3\,CaCl_2.$$

If calcium bicarbonate is added, the reaction is the same, except that CO_2 is also produced.

The atomic weights of the iron and of the hydrated lime are, remembering that ferric chloride contains 6 atoms of water of crystallization:

Fe,	55.84	x 2	111.68	Ca,	40.08	x 3	120.24
Cl_3,	35.46	x 6	212.76	$(OH)_2$,	34.02	x 3	102.06
H_2O,	18.02	x 12	216.24				
			540.68				222.30

Therefore, 222.3 pounds of hydrated lime will be required to react with 540.68 pounds of ferric chloride, and the amount of lime required can easily be computed for any dosage of ferric chloride. In computing the requirements for natural alkalinity, which is based on $CaCO_3$, the same procedure as for ferric sulfate is employed.

Iron and manganese are usually quite closely associated in water supplies and if one is present, the other is quite likely to be also. Iron is usually present as either ferrous bicarbonate, $Fe(HCO_3)_2$, which is soluble, or ferrous hydroxide, $Fe(OH)_2$. If oxygen is added to either of these, rust or ferric hydroxide, $Fe(OH)_6$, is formed which is insoluble. Therefore these iron compounds can be removed by oxidation, since the $Fe(OH)_6$ forming in water will settle out. Thus

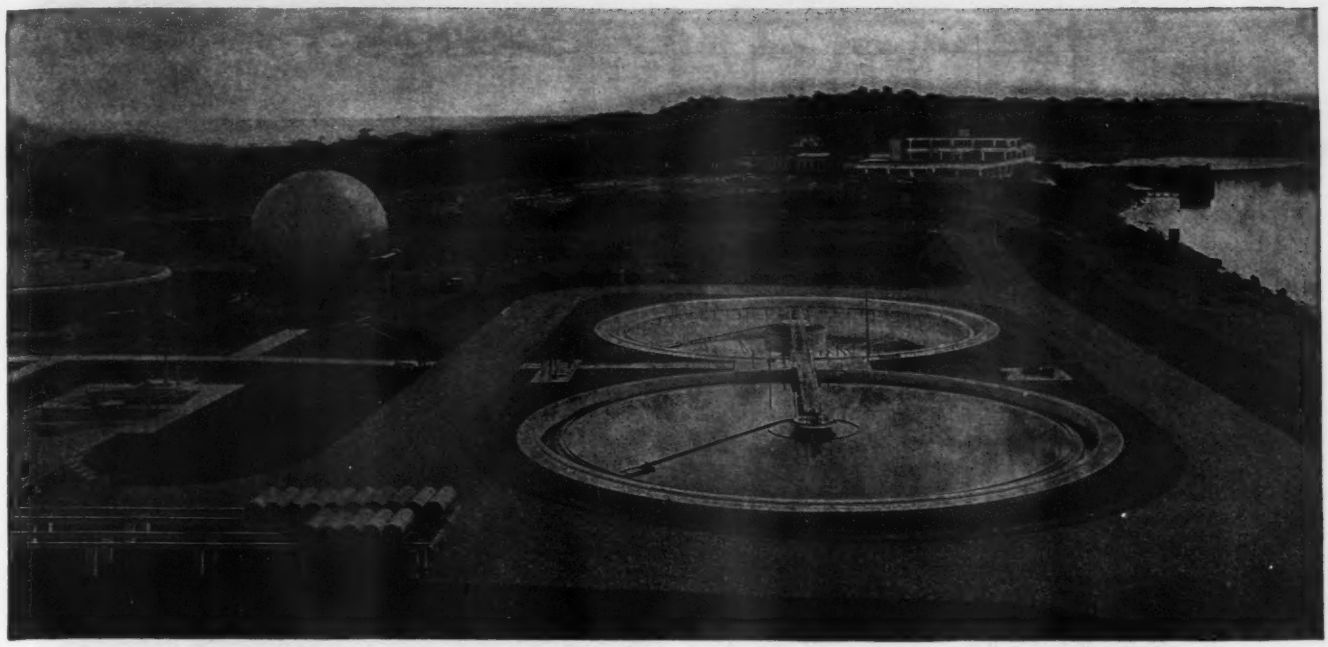
$$Fe(HCO_3)_2 + O + H_2O = Fe(OH)_2 + CO_2$$

By this reaction, the ferrous bicarbonate is converted to ferrous hydroxide. If more oxygen is then added,

$$2\,Fe(OH)_2 + 2O + 2H_2O = Fe_2(OH)_6$$

which is the insoluble ferric hydroxide.

Manganese is more difficult to remove. Manganese



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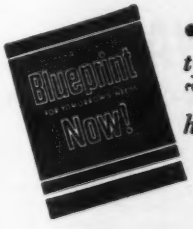

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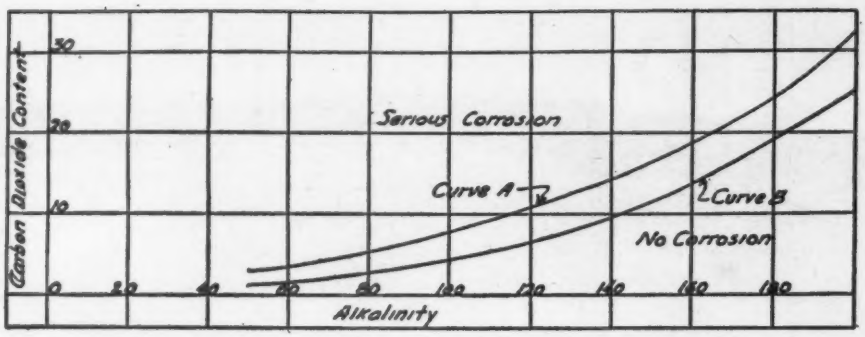

Fig. 12—Relation between alkalinity, CO_2, and corrosiveness of the water.

compounds usually found in water are manganese hydroxide, $Mn(OH)_2$, which is insoluble, or manganese dioxide, MnO_2. The reactions are not the same as with iron, and if much manganese is associated with the iron, it may interfere with iron removal. Chlorination is sometimes of value.

Other compounds sometimes present in water include fluorine and sulfates. These are removable generally only by means of special zeolites or other exchange methods, which are beyond the scope of this text.

Chlorination of water does not require a chemical knowledge, generally speaking. The amount applied is dependent upon the chlorine demand of the water and the amount of desired residual. Chlorine acts more slowly at higher pH values, so when the pH of a water is above 8.0 or 8.1 special precautions should be taken to assure a sufficiently long contact period before the water is used. The same rule applies to an even greater extent when chlorine and ammonia are used, and this method should not be relied on with waters having pH values above 8.0.

Corrosion is due to the solution of exposed metal by water; its rate is inversely proportional to the alkalinity and the pH and directly proportional to the content of dissolved oxygen, carbon dioxide, temperature and time of contact. The best method of preventing corrosion is to adjust the pH value, the CO_2 content and the alkalinity so as to deposit and maintain a thin coating of calcium carbonate on the interior of the piping system. In accomplishing this, the CO_2 content is the most important factor; only enough should be present to hold the bicarbonates in solution. The relation between the alkalinity, the CO_2 content and the corrosiveness of the water is shown in Fig. 12. It will be noted that a CO_2 content of 10 p.p.m. and an alkalinity of 80 p.p.m. will result in serious corrosion; while a similar CO_2 content with 160 p.p.m. of alkalinity will not cause corrosion.

The first step in corrosion control is to determine the CO_2 content (see Standard Methods) and the alkalinity to methyl orange. When these values are plotted on Fig. 12 the severity of corrosion will be indicated. Assuming a water with a CO_2 content of 10 p.p.m. and a methyl orange alkalinity of 80 p.p.m., which it is desired to reduce to zero CO_2. The general procedure given for softening is followed. The free CO_2 is 10 p.p.m.; the half-bound CO_2 is 44% of the alka-

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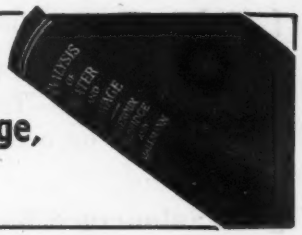

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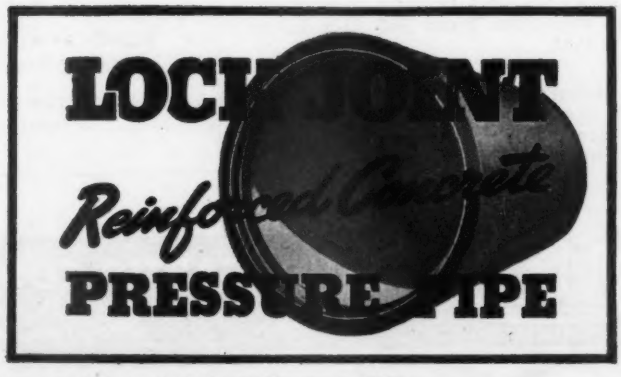

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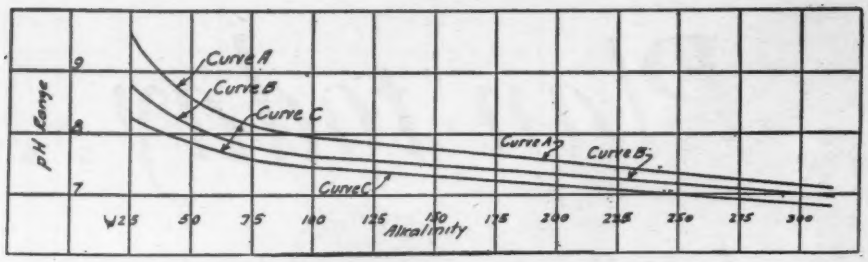

Fig. 13—Relations between pH, alkalinity and corrosion.

linity, or 44% of 80 p.p.m., or 35.2 p.p.m. Total CO_2 to be neutralized is 35.2 + 10 = 45.2 p.p.m. The atomic weight of $CaCO_3$, which is the compound that will be formed when CaO is added to CO_2, is 100.09, which the weight of CO_2 is 44.01 and of CaO is 56.08. For each part per million of CO_2, there will be required 56.08 ÷ 44.01 = 1.272 p.p.m. of CaO. Since 1 p.p.m. equals 8.34 pounds per million gallons, there will be required, for each p.p.m. of CO_2 8.34 x 1,272 = 10.6 pounds of lime per million gallons. For the 45.2 p.p.m. CO_2 computed above, there will be required 45.2 x 10.6 = 483.1 pounds of lime per m.g. If phenolphthalein alkalinity is also present compute bicarbonate alkalinity as indicated under *alkalinity*.

Fig. 13 shows the relation between pH, alkalinity and corrosion. If the pH and the alkalinity are determined and plotted on the figure and if the plotted pH and alkalinity fall above Curve A, calcium carbonate will be deposited; if below Curve C, there will be corrosion; if between Curves A and C, iron stains will be prevented and tendency toward any corrosion will disappear as Curve A is approached. By means of a jar or marble test, the amount of lime necessary to increase the pH sufficiently to prevent corrosion can be determined (see p. 37-38, PUBLIC WORKS, June, 1942).

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The chemistry of sewage treatment is complex. The changes that take place in the organic matter in the sewage during the process of treatment are both chemical and bacteriological. This text is not intended to cover such factors, but to present information actually of value in planning or operating treatment plants.

Elementary chemistry only is needed in computing biochemical oxygen demand loads on streams. For example, the B.O.D. of the effluent from a trickling filter is expected to be 45 p.p.m.; the stream into which the effluent is to be discharged has a dissolved oxygen content of 9 p.p.m., and it is desired that the minimum D.O. below the point of discharge of the sewage effluent shall be 3 p.p.m., what must be the volume of stream flow in order to dispose of a sewage effluent flow of 1 m.g.d.? Since there are available 9— 3 = 6 p.p.m. of D.O. and the B.O.D. is 45 p.p.m., the stream flow volume must be 45 ÷ 6 = 7.5 times as great as the sewage flow.

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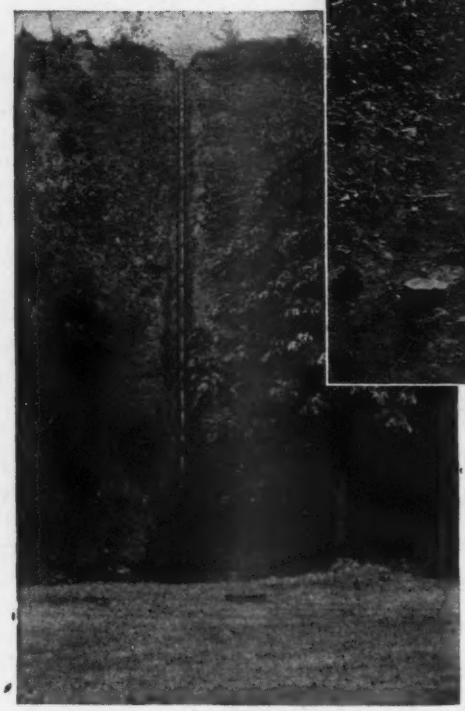

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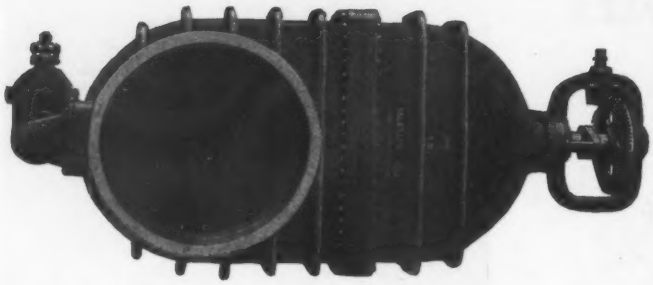

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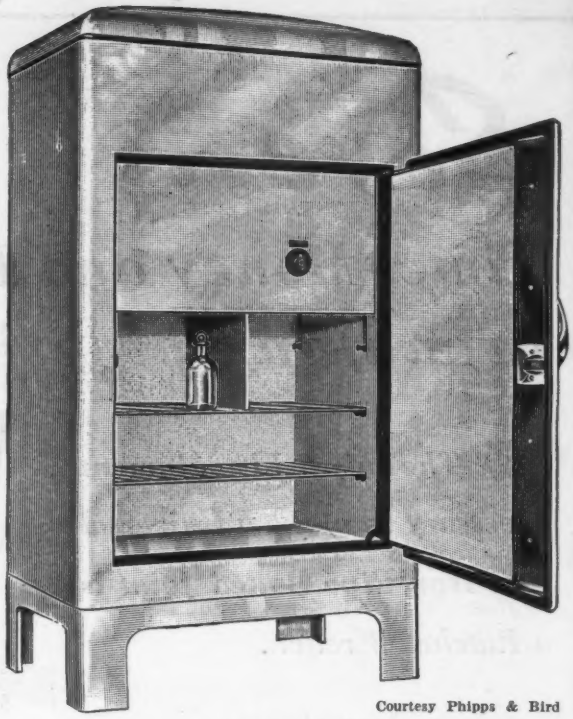


Courtesy Phipps & Bird

Fig. 14—Sewage Analysis Control Cabinet.

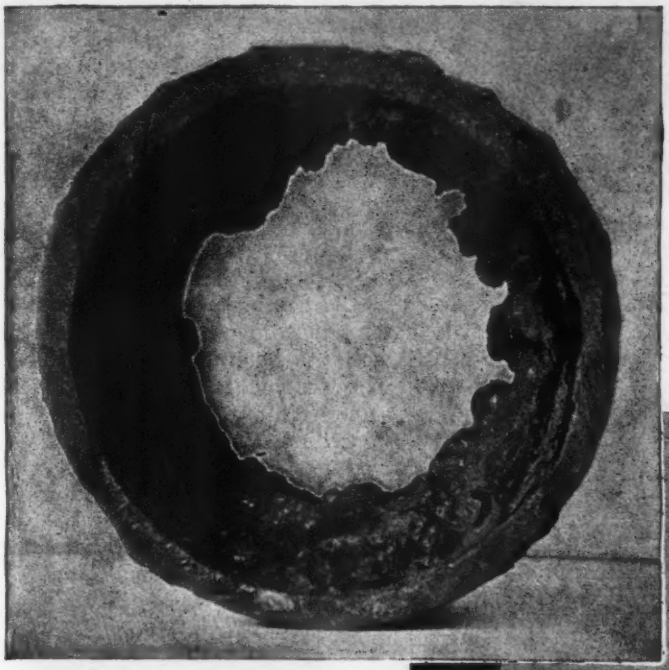
and alkalinty. Moreover, the rapid changes from hour to hour in the sewage pH and alkalinity content prevent the effective application of uniform dosages of coagulant. It is recommended in all cases involving sewage coagulation that hourly tests of pH and alkalinity (usually in sewage there will be only bicarbonate alkalinity) be made and plotted on a pH-alkalinity chart. These tests should be run over a number of representative days. Usually it will be found that at certain hours pH will be high enough to interfere with coagulation and that alkalinity may be great enough to cause redissolving of the floc, as described under "ionization." Jar tests, as described in PUBLIC WORKS, June, 1942, pages 34 and 36, should be carried out, and the need for and effect of recarbonation or other method of reducing the pH determined.

Both aluminum sulfate and ferric sulfate have been used effectively in sewage coagulation. The theoretical reactions are the same as those already described under coagulation of water, but actually may differ materially.

Acidity or excessive alkalinity of sewage may affect certain treatment process, as activated sludge or coagulation with chemicals. It may be desirable, under such conditions, to apply chemicals as a corrective measure. Due to factors already mentioned, as high organic content, suspended and collodial solids, and turbidity, the dosages required cannot be readily computed, but must be determined by tests, preferably in jars in the laboratory; these determinations must take into account the changes in pH and alkalinity from hour to hour and day to day. Ordinarily much more acid or alkali must be added than is theoretically needed. As an example, it is difficult to acidify sewage with sulfuric acid; this is, in part a matter of excessive cost, and in part due to the effect of the acid on sludge digestion.

Sludge digestion is influenced materially by the acidity in the digester; the pH of the sludge or of the supernatant liquor is usually considered to be an effec-

THIS?...



OR

THIS?

Sherburne, N. Y., after mains had been cleaned by The National Method and Equalizing reservoir installed.

WE CAN RESTORE YOUR WATER MAINS To Within 95% Of Original Capacity

There are more than 140,000 miles of pipe in the U. S. water supply systems that average over 30 years of service, according to Louis R. Howson, past-president of the A.W.W.A.

Many of these mains are so incrusted with foreign matter that their capacity has probably been reduced up to 50% of normal.

Clean those mains the "NATIONAL WAY," in from 5 to 7 hours, at night if necessary. The service can be resumed very quickly in an emergency.

WE OFFER YOU: (1) Greater carrying, (2) lower pumping costs, (3) improved pressure, (4) cleaner water, (5) lower insurance rates. Write for further information to any branch office listed below or to New York office:

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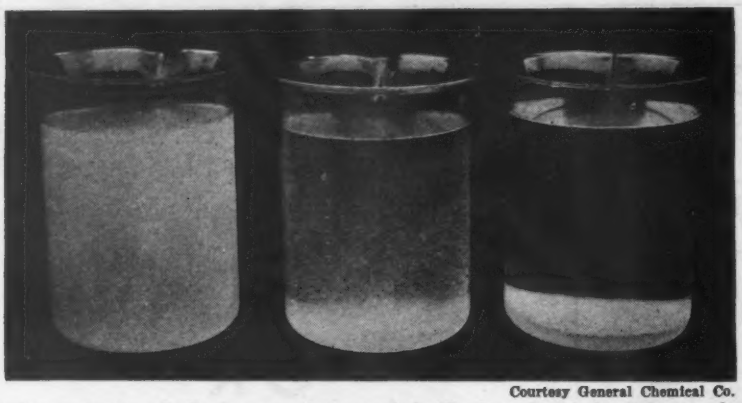

Courtesy General Chemical Co.

Fig. 15—Demonstration of effective coagulation and clarification of an industrial waste by means of aluminum sulphate.

tive indicator of the condition of the digesting sludge. Alkalinity tests on the supernatant provide a much more effective and sensitive test than do pH readings. The bicarbonate alkalinity of supernatant may range from 1400 p.p.m. to 4000 p.p.m. There appears to be no set rule for the optimum alkalinity. The operator should, by frequent sampling, determine the best operating range, and attempt to maintain it. When determining the alkalinity of supernatants, Standard Methods must be modified, since due to the very high alkalinity, an excessive quantity of N/50 acid is needed. Therefore, it is best to use a normal acid solution (or perhaps an N/5) until the end-point is approximated, and then to use N/50 for the final accurate determination. A little experience in handling any particular supernatant will indicate the best procedure.

A good resume in relatively simple terms, of the chemical reactions in a sludge digestion tank, will be found in the handbook on sewage treatment published by the National Lime Association.

Courtesy Phipps & Bird

Fig. 16—Sewage Sludge pH Outfit.

pH and alkalinity are considered by some to have an important part in any process of sewage treatment. It is believed that, in every plant, careful records should be maintained. If such records are based on periods of above-average, as well as periods of below-average operation, valuable leads for better operation may be obtained.

Oceana County Uses a Million Gallons of Brine a Year

(Continued from page 27)

In 1938 we applied approximately 500,000 gallons of brine with such a degree of success that in 1939 the Commission purchased another 2,000-gallon tanker and we applied 800,000 gallons in 1939 and 1,000,000 gallons in 1940. The war has slowed us

Designers of the famous "Water Buffalos"

IT TAKES a lot of things, like bullets, bombs, bayonets, bazookas—and *water*, to win a war. Cool, fresh, drinkable water in abundance. *Peerless Pumps* at the fighting fronts keep canteens filled—and keep our fighting men fit! Ever since Pearl Harbor, the building of *Peerless Pumps*, like the building of the justly famous "Water-Buffalo" Amphibian Tanks (also Peerless designed), has been an essential *War Industry*. Even in the days before the war, Peerless was producing *more* Deep Well Turbine Pumps than any other concern in America. As the leading manufacturer in the Industry, Peerless won recognition throughout the entire civilized world. On the great ranches, farms, orchards and irrigation projects. In the waterworks of our great cities. In the vast industrial plants. Wherever water is needed, there you find dependable Peerless Pumps, operating twenty-four hours per day, year in and year out.

Now that we are meeting the tremendous war-front demand for Pumps, we hope to be able to start "digging in" on our huge backlog of orders for home needs.

TURBINE TYPE
(Deep Well)
15 to 30,000 Gallons Per Minute

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Deep Well Pumps . . .

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They make bombers Fighting Mad

Bombers are pretty peaceful articles resting on the ground. But up in the air they're different birds. There's fire in their eyes.

What happens between the minute a bomber rolls out of a hangar and the time it takes to the air? Brother, you should see!

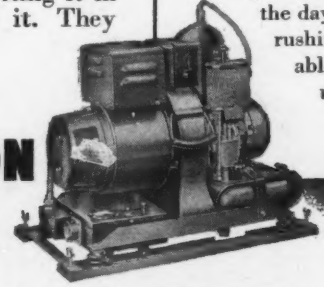
The busiest group of men you'll ever know start working on their pet. They gas her up. They stow the bombs. They check everything on the plane. And off to the side you'll see (and hear) the purr of the ground crew's faithful "putt-putt."

It's a Homelite Portable gasoline-engine-driven Generator . . . small, compact and *busy* . . . working for all it's worth, furnishing power for charging the plane's batteries and testing its electrical equipment . . . helping the boys in the ground crew to get the plane fighting mad.

It's not an easy life sparring with a bomber . . . getting it in fighting condition. But Homelites are able to take it. They do the job.

They Improve Dispositions

On the home front, Homelite gasoline-engine-driven generators are a blessing to busy construction men. Speeding up work with power for electric tools . . . stretching the day with night time lighting . . . rushing to emergencies with portable power . . . these Homelite units are always on the go.



HOMELITE CORPORATION

PORT CHESTER, NEW YORK

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back to the 500,000-gallon mark, but as soon as this war is won, we hope to better the 1,000,000 mark each year, except, of course, in unusually wet seasons.

Much can be said about controlling all of the factors in the preparation of the road bed and the application of the liquid chloride. The difficulty with dealing with a contract hauler is the necessity of synchronizing the work on the road and the application of the brine. With our set-up, we can apply the brine at the time when the section of the road to be treated is just right, that is, clay has been added and pulverized, more gravel can be added if necessary, and the road bed shaped and graded to the desired condition. Our brine tankers can be sent wherever we want brine and at whatever time we want it. We can load night or day at Manistee, so we could have 7,000 gallons of brine waiting for use at any time or place in the county.

In my judgment, the ideal way to apply calcium chloride is in a liquid form. The penetration is very rapid even when the road bed is dry. One drawback encountered in applying flake chloride is the fact that the flake chloride may lie all day on the road bed in the solid form, due to the lack of humidity in the air. An ideal time to apply brine is as soon after a rain as the road bed can be shaped up. The penetration then is almost immediate.

If the wearing surface of the road bed has been stabilized with clay, then after several applications of brine, this surface becomes exceedingly hard; so hard, in fact, that an under-truck scraper will not touch it. This condition would be a desirable one if it were not for the fact that the wearing surface in time becomes pitted. After a period of several weeks (we have gone as long as five weeks without having to grade on a primary road) the pits become too large for comfortable travel. At the begining, we thought this condition could be remedied only by a good rain or by scarifying the wearing surface, laying it out again and then applying more brine. This procedure continued to be a nuisance until we learned that all that was necessary was to "blade" in what loose material there was on the shoulders of the road and then apply another "shot" of brine.

Each application of brine consisted of 1,000 gallons per mile at any stage of the work. The average number of gallons per mile for the entire season amounted to 5,000 gallons, although the more heavily traveled roads received more gallons than the lesser traveled roads. A 5,000-gallon treatment is equivalent to 13,084 lbs. of desirable chloride solids; or the equivalent of 8.4 tons of a flake chloride, as a ton of flake chloride contains about 1,560 lbs. of chloride solids.

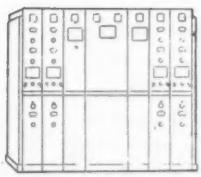
Our cost per gallon of applying it to the road averaged 0.4 cent for the entire county, which covered all labor and equipment rental. The material cost per gallon at Manistee was 0.6 cent, making a total cost on the road of 1.0 cent per gallon, or $5.35 for the equivalent of a ton of flake chloride.

The increase in our labor rate and maintenance cost has increased the cost of this dust palliative about 20%. The economical brine haul ends at approximately 125 miles, based on a 4-cent ton-mile rate. It is fortunate that our county lies within this radius from such a source of rich calcium chloride brine.

Since nineteen hundred twenty-two in Radio and Electronics

"Although as a rule GROUND FACILITIES receive little public attention, they provide the FOUNDATION upon which ALL AVIATION MUST BE BUILT. The sound growth of domestic air transport and, above all, private flying will require a considerable expansion of our system of airports and further IMPROVEMENTS of RADIO AIDS TO NAVIGATION and systems of TRAFFIC CONTROL."

WILLIAM A. M. BURDEN
Assistant Secretary of Commerce



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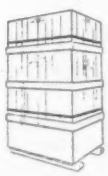
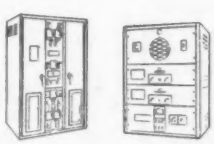


POSTWAR?



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Concrete slab maintenance costs can be reduced as much as 75% by the Koehring Mud-Jack Method. The Mud-Jack raises sunken concrete walks, curbs and gutters, driveways, streets, and airport runways eliminating reconstruction costs. Write for the new Mud-Jack Bulletin which is both illustrative and descriptive.

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KOEHRING COMPANY
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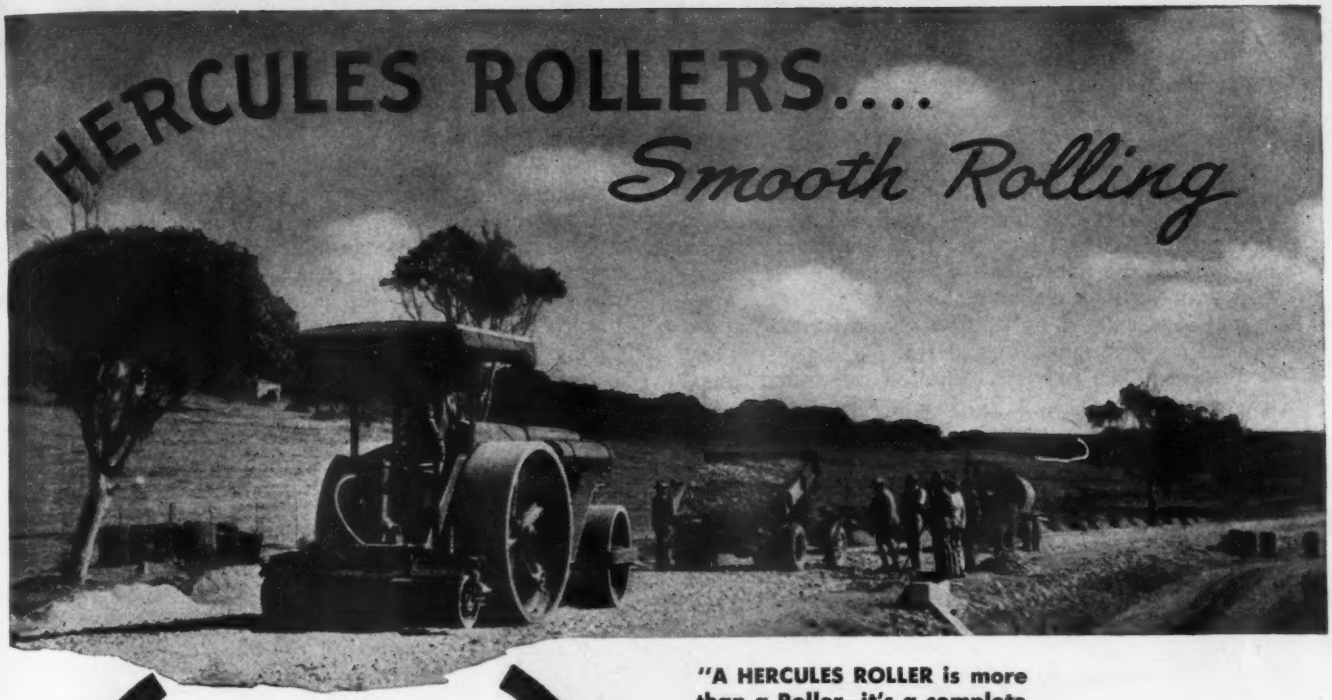
MUD-JACK METHOD



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From new headquarters there, or through authorized distributors, The Hercules Roller Company is prepared to furnish repairs and service information on machines in the field, promptly and efficiently. Bring your Roller problems to us.

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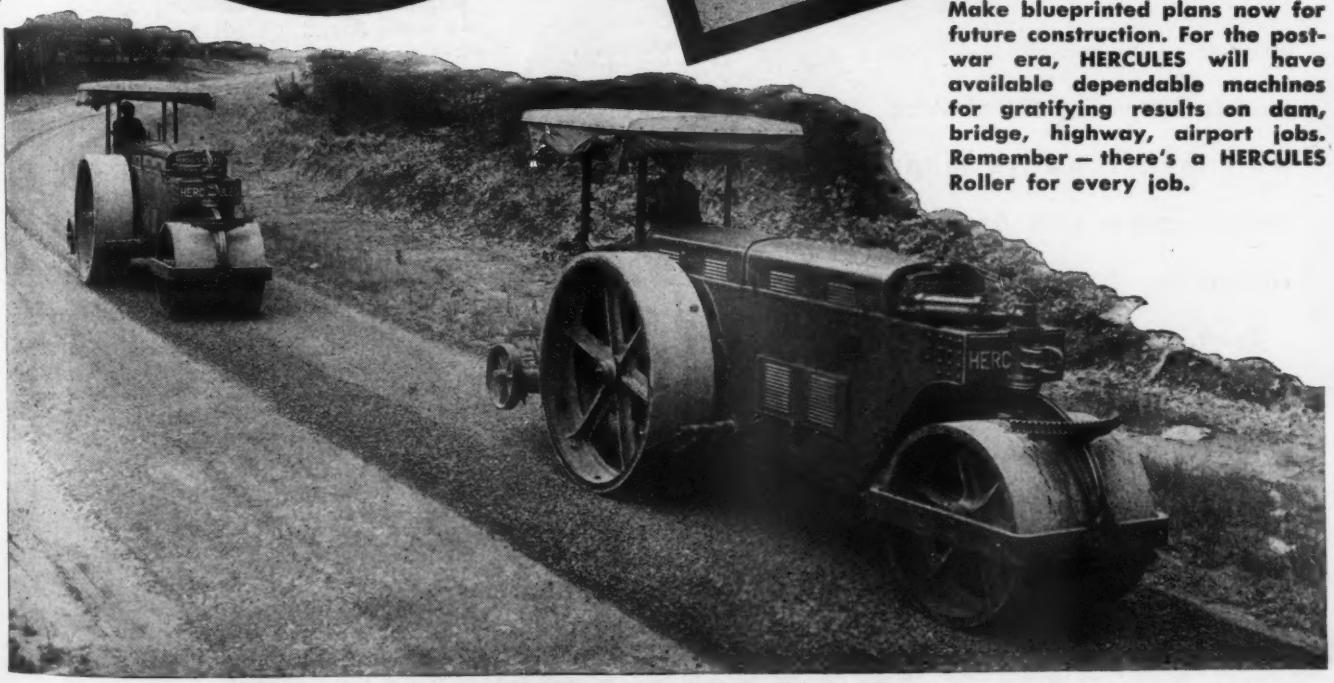
Make blueprinted plans now for future construction. For the post-war era, HERCULES will have available dependable machines for gratifying results on dam, bridge, highway, airport jobs. Remember — there's a HERCULES Roller for every job.



Construction of British Aerodromes

In the construction of aerodromes under the British Commonwealth Air Training Plan, certain general instructions are followed, which are abstracted as follows:

Drainage. Drainage systems in future will be designed on the basis of a run-off equivalent to 1 in. per hour of rainfall for the paved areas, and from 1/10 in. upward per hour for the unpaved areas, depending on the nature of the soil, and on the condition and slope of the turf. The size of the pipe required is calculated by using Kutter's formula and a coefficient of roughness of 0.015.

Runways. The runways consist of compacted gravel or crushed-stone base with hot-mix asphalt or bituminous penetration surfacing, according to the plant and machinery available at the site. Surfacings constructed by the penetration method have been found to need more surface dressing than hot-mix surfacings. At the ends of the runways, and where, during training operations, the aircraft are turned on the runways, concrete turning circles have been constructed.

The specifications for the several types of runway surfacings provide in general as follows: A. *Bituminous penetration wearing course.* Crushed stone passing the 2½-in. and retained on the 1-in. circular screen shall be laid and compacted on the prepared base to a depth of 2½ in. Bituminous binder shall be sprayed at a rate of 1.25 to 1.40 gal./sq.yd. as specified by the engineer. The surface shall immediately be covered by a layer of stone passing the 1-in. and retained on the ⅜-in. circular screen, rolled (with additional stone as required) until all voids are filled, and sealed with 2/5 gal./sq.yd. of the same binder, covered with a finer stone and rolled as before. B. *Hot-mix asphalt.* Crushed stone aggregate, graded from 100% passing the 1-in. screen to 15 to 25% passing the 10-mesh, shall be heated to between 200° and 275° F., mixed with the mineral filler, if required, and then with 4 to 6% of bitumen heated to between 175° and 275° F. The mixture shall be spread by a mechanical finisher, with the help of rakers, and rolled to a tolerance of ¼ in. under a 10-ft. straightedge. The sealing coat shall consist of 90 to 93% of fine aggregate (that part of the hot-mix aggregate passing the ¼-in. screen) mixed with 5.5 to 10% of bitumen, and spread at 35 lb./sq.yd. C. *Bituminous surface dressing.* Bituminous binder shall be applied at 1/6 to 1/5 gal./sq.yd., covered with clean, dry aggregate (½ in. down) and rolled. (In practice this was usually followed by a second coat of 1/5 gal./sq.yd. of bitumen covered with 15 lb. of sand.) D. *Base for roads, aprons and parade grounds.* This shall consist of two 3-in. layers of compacted gravel or water-bound macadam.

Planting Kudzu On Highway Banks

Work of maintaining steep roadbanks along Mississippi's paved highway system has been greatly simplified through the use of kudzu, an oriental legume, whose runners grow from 20 to 50 feet in a single season. The plant is a perennial and, once established, requires no replanting. Since the first planting in 1936 made on a highway near Meridian, a total of 347 miles of steep roadbanks along Mississippi's principal highways have been planted to kudzu.

"There is no maintenance cost to kudzu except an occasional mowing along the shoulders of the roadway," says J. D. Monette, acting chief state highway engineer in Mississippi. "Due to the good, deep root system and its ability to tie itself with vines from the top of the bank, kudzu is

ROLLING RUNWAYS TO TOKYO!!
Vital to every advance on the road to Tokyo are the airfields with their runways made carpet-smooth with American equipment.
Prominent in the preparation of these runways are Buffalo Springfield rollers . . . the same rollers that will again serve in peacetime.
BUFFALO SPRINGFIELD ROLLERS
THE BUFFALO SPRINGFIELD ROLLER COMPANY
SPRINGFIELD, OHIO, U. S. A.

not as susceptible to land slides as most other types of vegetation."

"One good feature of kudzu," Mr. Monette adds, "is the longer it stays, the better it gets; whereas under certain conditions, the longer grass stays the poorer it gets."

The plant grows from Maryland to Florida, but it is probably best adapted to the middle and lower South, where the growing season is long and annual rainfall is relatively heavy. Other southern states have used it for control of highway erosion, but none to the extent that Mississippi has.

New Scraper Blades From Old by Welding

(Continued from page 23)

concrete floor of the shop and broke in several pieces. Our mechanic took a 12-inch channel, welded some legs to it, put the welded blade on it and covered it with some old signs or other pieces of sheet steel; then he inserted a gas torch, first at one end and then at the other, and brought the blade to a red heat, after which it was allowed to cool by itself. Since we adopted the annealing process we have never had a blade break, although our six Caterpillar Diesel motor patrols give plenty of opportunity on our 312 miles of sand and crushed rock surfacing, which we maintain when the surface is dry as well as after rains. (We have periods in this part of Kansas when no rain falls for several weeks.)

I might suggest that a better method of annealing would be to run a gas pipe under whatever support is used for the blade and space gas jets at intervals, the base to be a grating of some sort, and the whole blade heated at one time. Not such a bad idea—think I will try it myself.

Maintenance Records for Waterworks Operators

An operator's card that is used by the St. Louis County, Missouri, Water Company is believed to be very practical. It could be called a reminder record and will fit into the smallest or the largest of plants. It is a daily, weekly, monthly, quarterly, semi-annually, or annual reminder card.

This is the way it works:—Sit down and make a record of all the things you do around the plant and on the distribution system such as operating and inspecting valves, fire hydrants, checking chlorinator or any other operation that should be done and then figure how often you should do that one thing and indicate it on the card with the date for doing it. Example—suppose you blow off, test and check the fire hydrants twice a year, say in June and in September. File the card under the month of June. Then when June comes, take the cards out for that month and when the hydrants are tested make a note on the back of when and by whom the check was made, the condition of the hydrant and also note what repairs were made. Then file it under September. In September when the card is again used you will know just what you had to do the last time. After the September inspection file it under June again.

From *The Clarifier*, the bulletin of the South Dakota State Board of Health.

No. 101
UTILITY
SPRAY TANK
Here's the Black Top Unit that will play a vital part in the building of Post-War Roads, Highway, Runways, etc., due to its Utility. It is three units in One—Spray Bar for small application jobs—Hand Spray for patch work—Pouring Pot Outlet for crack filling, etc.
No. 101 Utility Spray Tanks are made in trailer or truck mounted models. For better roads, for a better future, use the best equipment, Littleford Black Top Equipment.
LITTLEFORD
BLACK TOP ROAD MAINTENANCE EQUIPMENT
SINCE - 1900
LITTLEFORD BROS., INC.
452 East Pearl St., Cincinnati 2, Ohio
Model No. 101 Utility Spray Tank 2 wheel trailer model.

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Sanitary Engineering Services in the First Service Command

(Continued from page 22)

turned to their stations to assist the Post Sanitary Officer in his pest control work. Although pest control, following the historic case of the "Quartermaster ant and the Engineer ant," has been made the responsibility of the Post Engineer it was found practical in some cases to use medical enlisted men in the execution of such work. In this as in all other phases of sanitation it has been the primary object of both the Engineers and Sanitary Corps to get the job done and not to quibble over sharp lines of responsibility.

When the vermin control program was set up, it was thought that such work would be handled on the complaint of individual units. It was soon found that complaints were not being submitted, either because vermin infestations were not recognized or because pride of individuals would not permit them to admit the presence of such embarrassing creatures as lice or bed bugs. It was necessary therefore to organize a definite inspection program to discover infestations and this has been done by using trained enlisted men to inspect all mess halls and barracks on a routine schedule.

The problem of rat control is closely tied in with the disposal of garbage and rubbish. At practically all Army installations the edible garbage is sold to civilian contractors for hog feeding. However, enough material to provide food for rats is found in trash and "non-edible garbage" which finds its way to dumps or incinerators. In certain cases, particularly on islands, garbage grinding is practiced and has proved to be satisfactory. (See *Public Works* for March, 1943). The use of sanitary fills and incinerators has proved to be a practical and sanitary means for disposal of wastes. It is the duty of the Post Sanitary Officer to inspect all phases of garbage handling from the point of origin to final disposal to make certain that no unsanitary conditions arise, especially those which lead to fly and rat breeding. In some instances where dumps were not properly operated, the rat population increased alarmingly, and changes were found to be necessary. In one case it was decided to cover the old dump and start a new sanitary fill in another location, but rather than force the rats to scatter to other parts of the post it was decided to exterminate them. The photograph on page 20 shows part of the catch. This one campaign killed an estimated 4000 rats.

The use of sanitary fills has become well established. It has been necessary to teach many officers the difference between a common dump and a sanitary fill, but the results have been encouraging. One fill is illustrated, showing the trench into which waste is dumped from trucks on the right, to be covered by the drag-line on the left, which secures covering material by excavating a similar trench beyond the active face of the fill. In this case, a drag-line only is used. Other equipment is used at installations of different population. The trucks are standing on previously made fill, the traffic aiding in compaction of the material.

One of the major features of the Sanitary Engineering Service is the training and assignment of personnel. Engineers who have been commissioned in the Sanitary Corps are well trained and experienced in

YOUR ATTENTION, PLEASE!
One of these days, we hope soon, millions of demobilized service men will be looking to you for jobs. They will expect you to have this work ready. With the great reservoir of badly needed water works and sewage works maintenance, rehabilitation, and expansion that has been piling up, there can be no excuse for not having everything in BLUEPRINT FORM — READY FOR CONTRACT.
Once again, we join the Committee on Water and Sewage Works Development in urging you, for the welfare of our service men, your community, and the Nation at large, to determine tomorrow's needs today and BLUEPRINT NOW!
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ESTABLISHED IN 1892
Made by R.D. WOOD Company
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A life-giving drink of fresh sea water

PERMUTIT DESALTING BAG
INSTRUCTIONS
1-FILL BAG TO LINE WITH SEA WATER
2-ADD BRIQUET OF CHEMICAL. ROLL TOP OF BAG DOWN AND STRAP SECURELY.
3-ALLOW BRIQUET TO STAND FOR A FEW MINUTES. THEN KNEAD BAG WITH HAND FOR 10 MINUTES UNTIL BRIQUET IS BROKEN INTO A FINE POWDER.
4-SHAKE BAG OCCASIONALLY FOR 30 MINUTES SO DESALTING MATERIAL IS KEPT IN CONTACT WITH WATER.
5-NOW SUCK CLEAR FILTERED DRINKING WATER THROUGH OUTLET TUBE.
THE PERMUTIT COMPANY
WORLD'S LEADING WATER CONDITIONING SPECIALISTS FOR MORE THAN 30 YEARS
PATENT PENDING

THIS flyer, down at sea, may suffer many hardships. But he'll be spared the most dreaded of all—thirst. He'll drink sea water—and live!

Stowed in his rubber raft, he'll find a Permutit Sea-water Desalting Kit. It consists of a plastic bag and a supply of salt-removing briquets. That's all he'll need to change salt sea water into fresh, clear drinking water in a few minutes. The kit occupies only one-tenth the space of the drinking water it produces.

The Desalting Kit was developed by chemists and engineers at Permutit, and accepted by the U. S. Navy, Army and Air Transport Command.

Permutit is helping thousands of war plants and Army and Navy establishments to do a better war job. We are proud indeed that our skill enables us also to make the tough job of our front-line fighting men a little easier, a little safer.

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PERMUTIT

Serving industry and the armed forces...with GOOD WATER

When you need special information—consult the classified READER'S SERVICE DEPT., pages 96-99

their particular line such as water supply, malaria control or similar specialty, but it is extraordinary to find an engineer whose training and experience include all phases of Army sanitation. It is necessary therefore to round out any deficiencies by some program of effective training. This is done in several ways. After preliminary basic military training, officers are assigned by the War Department to Medical Department Replacement Pools, one of which is located in the First Service Command, to await a permanent assignment. When an officer reports to the pool, he is immediately assigned on temporary duty to some post in the Service Command where he can work under the supervision of the Post Sanitary Officer, and learn by doing. If necessary, an officer may be rotated through different assignments, but usually such temporary duty is rather brief, since officers are assigned to permanent positions as fast as vacancies occur.

A similar arrangement can be followed with a certain number of officers newly attached to the Service Command by assigning them as assistants to Post Sanitary Officers at large stations; later, as the situation warrants, placing them in a post by themselves. Another very practical procedure is to conduct conferences at which ideas can be exchanged and instruction given in subjects of general interest. At these conferences it is customary to spend some time on field demonstrations and to make full use of pictures or visual aids, rather than to reply entirely on a lecture and discussion. It has been found desirable to include as speakers not only Army personnel but civilians also, gaining the advantage of excellent technical discussion and emphasizing the fact that public health is a mutual problem for military and civilian establishments alike. Many Federal Government agencies such as the U. S. Fish and Wildlife Service, U. S. Public Health Service, The Bureau of Entomology and Plant Quarantine and others have provided speakers and material for instruction and discussion. State organizations have been unsparing in their assistance and with small wonder, since an appreciable proportion of Sanitary Corps officers have been recruited from various state health departments and the liaison is very close. The conferences have proved to be of considerable value in standardizing services at all posts, in improving technical knowledge and skill, and in developing the confidence of individual officers in their own abilities and techniques. Other training is given to officers at their own posts by specialists who visit the posts and review individual problems with the officers concerned. These specialists are drawn from any source available, some civilian, some military, and it is the duty of the Service Command to provide them whenever needed.

The aim of the sanitary engineering service in the First Service Command is two-fold. First, it is to provide inspection service to investigate adequately the sanitary condition of the Army, and incident to this inspection work, to provide expert advice and assistance to improve sanitary conditions. Secondly, it is to provide a reservoir of trained officers to be available for overseas or other assignment by the War Department. This is contrary to the civilian administrative policy of tenure; it is in line with the Army concept that "no man is irreplaceable" and replacement of experienced officers with others less experienced is the normal situation. The problem is to maintain con-

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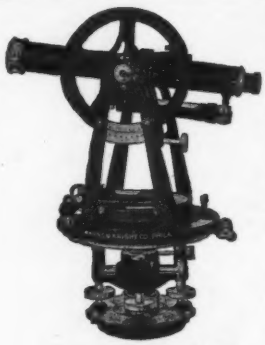

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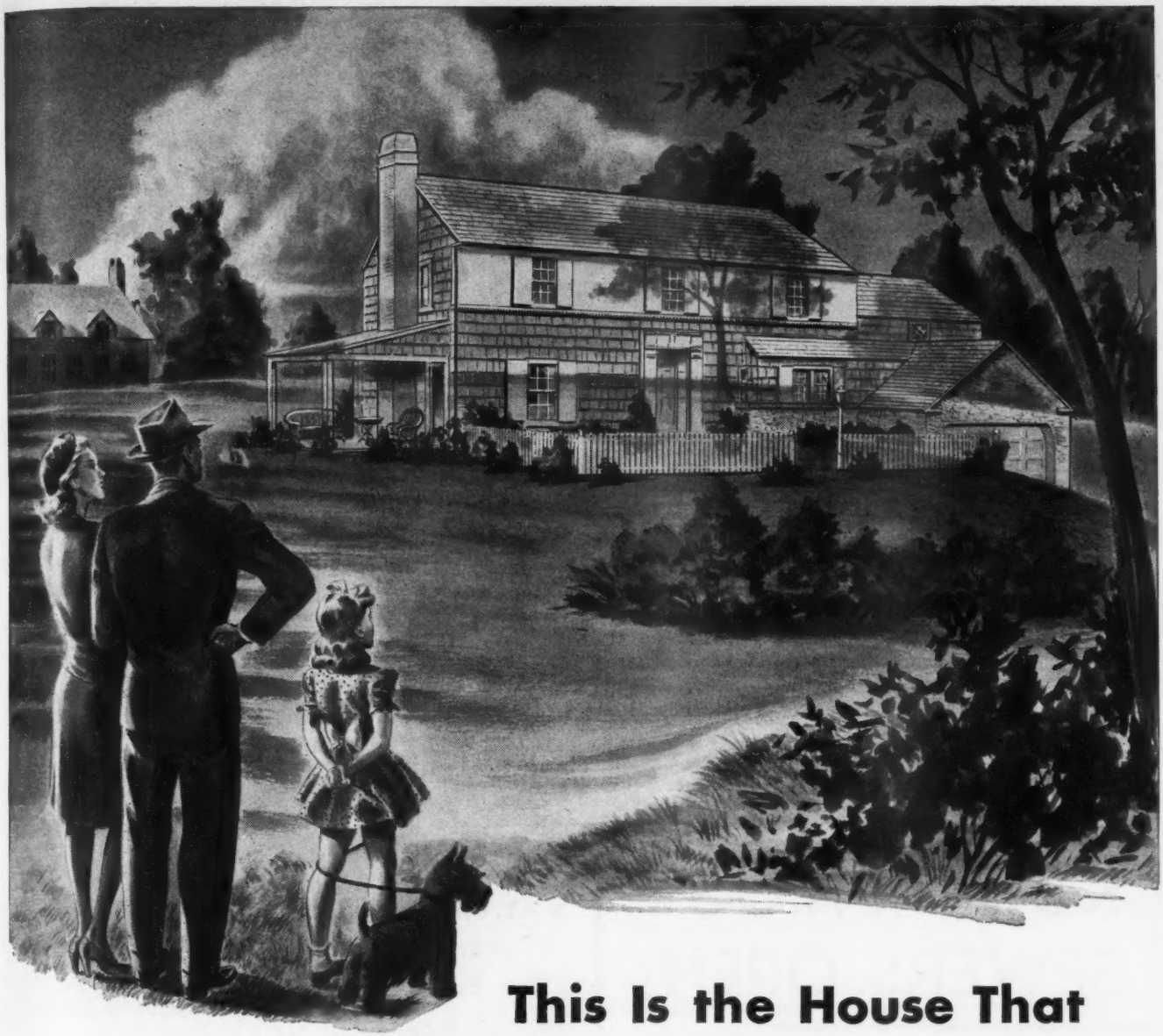

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tinuity of service with rapidly shifting personnel, and the fact that this has been done successfully reflects the high degree of adaptability and the uniformly high level of professional standards which seem to be inherent in the newly commissioned officers sent to the First Service Command for duty. It is to the great credit of the sanitary engineering profession that so many capable engineers have been found ready and fit to step into such military assignments and do such an excellent job. Their part in keeping soldiers fit for training and duty has been a very real contribution to the war effort.

How Soon Can You Rewind My Motor?

(Continued from page 28)

ring. Observance of the following points will save time and headaches:

1. The stator of a horizontal motor of the same make, speed and frame number will probably fit the vertical motor perfectly, and the cast-on feet will not be in the way. Try this first.

2. If a larger horizontal motor is used it may be necessary to employ the vertical motor electrical supply circuit as a pilot control on a temporary service and contactor large enough to start and run the larger motor. Otherwise the circuit wiring and overload protection may not be adequate.

3. On units up to ten horsepower the motive power must be at least ten feet away.

4. The center line of the driving pulley should line up with the side of the rotor on which the belt pulls.

5. The driving pulley should pull bottom and its top should be about nine inches above the center line of the driven rotor.

6. A crown on the rotor made by winding on friction tape will materially assist the belt in tracking. Varying the belt tension slightly will also help it to run more evenly.

7. If the pump has no foot or check valve it may do some reverse motoring when it is shut down. This may be hard on the quarter turn belt installation, but it may be helped by mounting a lawn mower near the pump with the roller just clearing the running belt. When the belt reverses the roller is much easier on its edges than the sharp rim of the end bell.

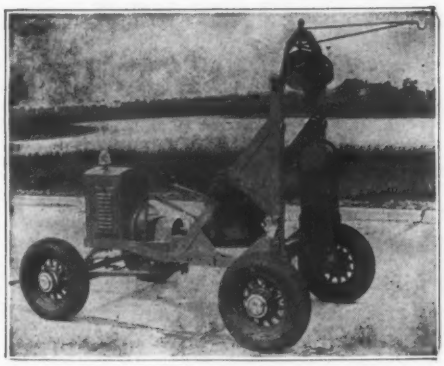
8. The driving motor or engine should be firmly bolted to a two-inch plank base. If the floor is concrete the planks should be long enough to brace against the pump motor base and extend back to a doorway or other permanent anchorage to keep them from crawling under vibration and belt pull. Scabs may be used to brace against other machinery, window casings, pipes, etc., to accomplish the same purpose.

9. The installation should be closely watched, as labor is cheap compared to lack of vital water supply, too much sewage, or a demoralized industry.

10. Do not try to run the pump at higher than normal speed, as discharge pressure increases as the square of the speed, and power input (which increases as the cube of the speed) may injure the pumping equipment.

This method can be extended in dire emergency to pit motors or motors in constricted spaces by mounting the temporary drive above the damaged motor and using two idler pulleys to change the belt direction

KEEP THOSE SEWERS OPEN!



Sewers clogged with sand, roots and other debris are a constant danger to public health and safety. New installations rapidly lose their efficiency due to sand seepage.

You positively can keep the sewers of your city open with an OK Champion—the cleaner that does the entire job from street level. Dig-ups practically a thing of the past.

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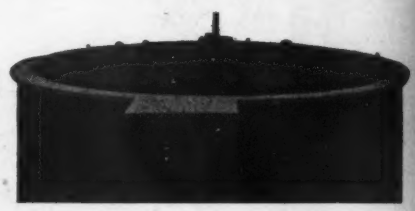

The health of our fighting men and war workers is being safeguarded by modern sewage disposal plants. We are doing our part by delivering on time P.F.T. Floating Covers and other sewage treatment equipment.

The P.F.T. Floating Cover for single and stage digestion hastens the digestion process, and provides for utilizing the sewage gas to heat water for the digester tank.

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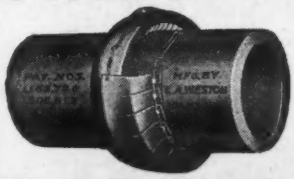

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10 lb. PIGOT FORM
Easy to ship, store, handle and work

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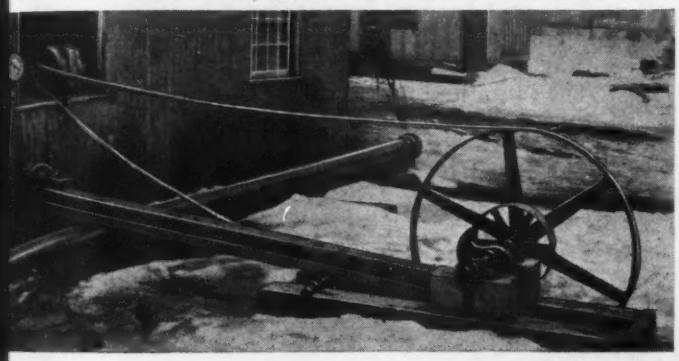

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is, we believe, the most convincing demonstration of durable jointing on record. It's a story of compelling interest to everyone who have to do with water line specifications and laying. Write for your copy NOW! Address our head office at Mertztown, Pa.

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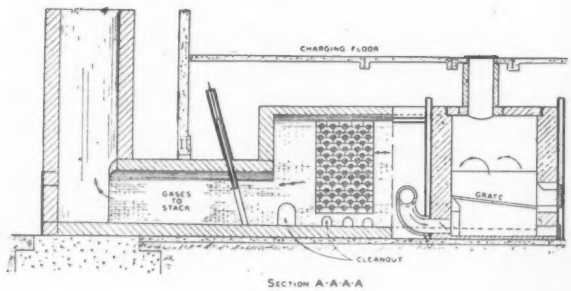

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from vertical to horizontal. At one time we even mounted a gasoline engine on a pump house roof, cut holes for the belt and fastened the idlers to a yoke clamped to the pump discharge pipe. Many difficulties can be overcome by a little ingenuity and perseverance.

Rehabilitating a Gravel Well

(Continued from page 18)

pipe was within 12 feet of the bottom of the original hole. Much of the material removed was a fine silt, clay and sand extremely black in color.

After driving the 12-inch screen to a depth of 170 feet, a 4-inch bailer was used to remove the sand and gravel, this size being able to enter the 10-inch screen extending up into the 12-inch, which was bailed out to the concrete plug at the bottom of the original hole. The 12-inch screen was then cut off at a depth of 61 feet, allowing a 5-foot lap in the 19-inch casing.

The pump was installed and placed in operation on April 26, 1943, and delivered 2.1 m.g.d. as compared to the 1.4 m.g.d. to which it had fallen off. The water, when first pumped, was a gray cloudy color of 180 p.p.m. turbidity. This condition would exist for about one hour, after which it would clear up. In order to remove this clay and silt deposit from the well, we would surge the well at one hour intervals by shutting down, and starting up again as soon as the water returned to its static level. This was continued for several weeks before the turbidity was entirely eliminated.

This well has now been in operation almost a year and the rate of delivery is still holding at 2.1 m.g.d. with no increase or decrease noticeable.

The entire work was performed by The Poe Drilling Company, a local well drilling concern, and we believe the work was successful in that we now have a well of 2.1 m.g.d. capacity with new screen and casing which will probably last for another twenty years.

Winners in National Fire Waste Contest

The Chamber of Commerce of the United States, cooperating with the National Fire Waste Council, annually conducts a contest between cities of the United States based upon reduction of fire losses; thorough and continuous educational efforts in fire prevention, highlighted by spring clean-up and fire prevention week campaigns; all-out community organization for fire prevention; fire hazard inspections; adoption of building and fire prevention codes; and permanent improvements, such as maintenance of and additions to fire fighting equipment, installation of fire extinguishment and alarm equipment, training of firemen and fire safety employees. Cities compete with their own individual fire safety records of previous years as well as with other participating cities.

This year the awards went to the following cities: Cincinnati for cities of more than 500,000 population; Indianapolis for those of 250,000 to 500,000; Hartford for those of 100,000 to 250,000; Pittsfield, Mass., for those of 50,000 to 100,000; Parkersburg, W. Va., for the 20,000 to 50,000 class; and Ft. Collins, Colo., for those of less than 20,000.

The contest, which has been operated yearly since 1922, has been centered since Pearl Harbor in reduction and control of wartime fire losses. Cities in the contest represent a total population of more than 40,000,000.

Chemical houses of the Kansas City, Mo., water softening plant; storage silos at the right.

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

Reclaiming Scrapped Meters

When the East Bay, Calif., Municipal Utilities District found it almost impossible to replace meters and parts it had on hand 810 meters discarded as irreparable. A chemical cleaning process was developed by which 790 of these were reclaimed and put back into service, at an average cost of $4.50 each for new parts, gears, labor, etc. The same process is now used for cleaning meters by mass production methods, one man cleaning over 500 meters a day with better results than by hand scraping and brushing 15 to 20 a day. In this process, dirt is washed off, all parts but gear trains and rubber diaphragms are degreased by a hot alkaline emulsifying and cleaning agent, rinsed, and immersed in an inhibited acid type scale solvent which removes encrusted solids, carbonate scale, corrosion and verdigris; rinsed and dipped into a solution for thoroughly neutralizing the acid; rinsed, put in a passivating solution for 30 seconds and rinsed again. This not only removes all verdigris but prevents its reappearing.[F20*]

Bromine and Chlorine Dioxide as Disinfectants

Increased production of bromine as a by-product at war plants and restrictions on the use of chlorine led to investigation of the comparative effectiveness of the two in disinfecting water. It was found that chlorine dioxide can be used as a bactericide, but is much less effective than chlorine except in waters extremely low in organic matter, and has less residual effect, also less tendency to produce chlorphenol tastes. Neither bromine nor chlorine dioxide is as effective as chlorine, although either could be used as a bactericide. Both are more affected by the organic matter in the water than is chlorine, and neither has nearly as much residual effect as chlorine.[B11]

Uses of The Pitometer

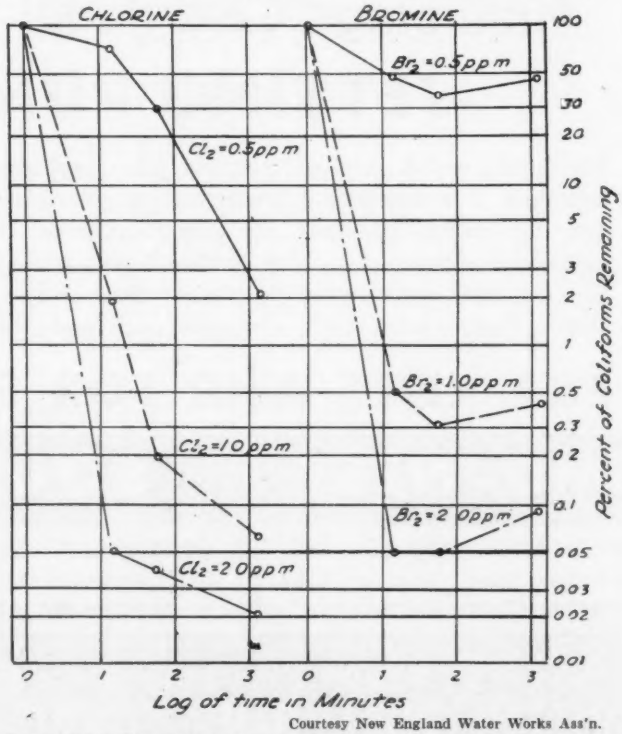
These were described under three headings: Water waste surveys, trunk main surveys, and distribution studies. Under the first, it was stated that many cases of leaks are on record where it was not possible to hear a definite noise with any type of listening device. Often, the larger the leak the less the noise it makes in escaping underground. Flow measurements often reveal losses other than leakage. In some large cities, notably Pittsburgh, Boston, Cincinnati and Rochester, waste surveys are carried on during favorable weather every year, covering the entire system about once every five years.[B13]

Cisterns for Fire Supplies

Based on investigations in England, the author suggests that cities have separate water systems for fire fighting, consisting of a large number of individual unit systems, each unit protecting a block or group of blocks, and getting its primary supply from a gravity tank and a secondary supply from ground tanks or reservoirs. In each unit there would be a system of piping separate from the regular public water system, provided with section valves in much the same way as an industrial water system is laid out. Sprinklers and standpipes in buildings would be supplied from these independent systems. The function of the domestic system would then be to supply water for tank filling purposes only. The English reservoirs are covered to prevent children and rubbish falling into them. (Many uncovered ones have life preservers hanging on the fences that surround them.) In the United States, San Francisco has three separate sources of water for fire—the normal water supply, a high-pressure system, and a system of cisterns of capacities ranging from 50,000 to 100,000 gal., completely under ground.[B8]

Interconnecting Water Systems

Since 1941 interconnections have been made between the water systems of Buffalo, N. Y., of cities and villages adjacent to that city served by the Western New York Water Co., and the cities of Tonawanda and North Tonawanda. Buffalo's filters have a rated capacity of 160 mgd, have operated for short periods at 200 mgd, while its consumption averaged 130 mgd with peaks of 180. The W.N.Y.W. Co. filters have a rated capacity of 16 mgd and have been supplying 19 to 20, and certain sections of its territory received inadequate volume and pressure. Tonawanda and North Tonawanda have no storage. Therefore these districts were connected to the Buffalo system for emergency service although it was thought that that city could not legally sell water outside its limits. Nine non-permanent emergency connections were provided by locating fire hydrants near each other, one in each system, to be connected by hose in an emergency. A booster pump in the W.N.Y.W. Co. system has a suction connection to the Buffalo system. This work was financed entirely by FWA. Later the State Attorney General decided that Buffalo could sell water outside the city



Courtesy New England Water Works Ass'n.

Bactericidal effect of bromine and chlorine in Merrimack river water.

*See Bibliography for May.

limits, and City Council authorized selling 7 mgd, but the emergency connections probably will be used only in case of fire, disaster or enemy attack. No use of them was made until Dec. 23, 1943, when ice partially closed the W.N.Y.W. intake for several hours and Buffalo furnished water at the rate of about 9 mgd for a short time; and the next day a 60" main in Buffalo broke, and the W.N.Y.W. Co. supply was a fire stand-by for the several hours before it was repaired.[G17]

A Practical Test of Fluorine

To test whether fluorine in a public water supply will decrease decay in children's teeth, sodium fluoride is to be mixed with the water supply of Newburgh, N. Y. at the rate of 1 ppm. About 32 miles away is the city of Kingston with about the same population—32,000, and its water will not be so treated, and a comparison will be made of the tooth decay in the two cities over a series of years, about 3500 school children in each city having their teeth examined at least once a year.[F27]

Activated Carbon in Canada

In 1942, activated carbon was used at 23 Canadian municipal water treatment plants, consuming 76,115 lb. of carbon, or 4.13 lb. per million gal. of water consumed; the rate per mil. gal. of water actually treated reaching a maximum of 120 lb. The cost was 41 cts. per mil. gal. of water consumed.[M10]

Wages of Water Works Employees

The Federal Fair Labor Standards Act requires payment of wages or salaries at 1½ times the regular rate for time in excess of 40 hr. a week, if the work is in interstate commerce or "in an occupation necessary for the production of goods for interstate commerce." The Wage and Hours Division of the Dept. of Labor in 1942 interpreted this to apply to "employees engaged in producing . . . water for use within the State by railway terminals or depots, telephone exchanges," etc.; also in producing water "used or consumed entirely within the State in the production of other goods for interstate commerce."

In January 1944 the Supreme Court of Missouri handed down a decision in an action brought by employees of the St. Joseph Water Co., in which it said: "Our conclusion is that the plaintiff's connection with the production of goods for commerce (furnishing water to brewing and bottling companies) was too remote and tenuous to bring them within the Act; and that their work for defendant cannot reasonably be said to be so closely connected with such production as to be practically or essentially a part of it."[A68]

Electric Grounding On Water Pipes

In 1940 the Water Works Practice Committee of the A.W.W.A. decided to initiate a research program on the effects of electrical grounding on water quality, and the association allotted funds to establish a research fellowship at the College of Engineering of New York University. In making the research, red brass, copper, galvanized iron and lead pipes were used; three lengths of each type, one subjected to a grounding current of 1.25 amp. of alternating current, the second to 1.25 amp. of direct current, and the third completely insulated against any current. Water from New York's Catskill supply (pH 6.95, hardness 19 ppm, alkalinity 11 ppm) was retained in the pipes for periods ranging from 6 hrs. to 32 days, analyses of it being made before and afterward, and increases in metallic concentrations tabulated and plotted. No appreciable increases could be determined, any differences that might possibly have existed being far outweighed by many other factors effecting the corrosion of metallic pipes. It was concluded that electric grounding of 1.25 amp. of current on service pipes constructed of any of the metals used had no appreciable effect.[A74]

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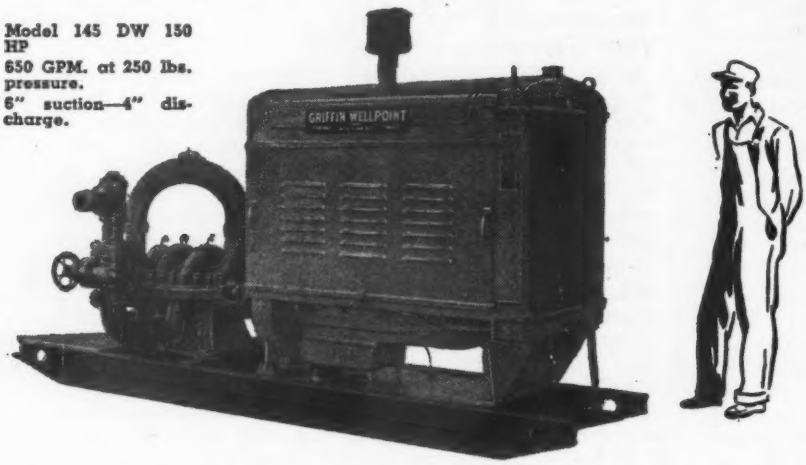
6" suction—4" discharge.



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When you need special information—consult the classified READER'S SERVICE DEPT., pages 96-99

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal, American Water Works Ass'n.*
May

67. Sanitation Manual for Public Ground Water Supplies. Pp. 501-534.
68. Federal Fair Labor Standards Act and Water Companies. Pp. 535-541.
69. Safety in Water Main Construction. By Fred Eitel. Pp. 542-545.
70. Stop Waste—Look After Your Pumps. By Morris L. Hicks. Pp. 546-552.
71. Pump Maintenance. By Harry Stock. Pp. 553-556.
72. Maintenance and Repair of Meters. By George A. Roden. Pp. 557-559.
73. Hydrant and Valve Inspection and Maintenance. By Carl W. Seemann. Pp. 560-562.
74. Effects of Electric Grounding on Water Pipes. By Rolph Eliassen and Philip Goldsmith. Pp. 563-576.
75. A Checklist for the Water Works Executive. Pp. 577-580.
76. Check the Use of Water. By D. E. Davis. Pp. 599-601.

B *Journal, New England Water Works Ass'n.*
March

4. Activities of the Committee on Water and Sewage Works Development. By E. L. Filby. Pp. 1-6.
5. Postwar Plans for the Water System of New Bedford, Mass. By Howard C. Mandell. Pp. 7-13.
6. Public Works After the War. By Elizabeth M. Herlihy. Pp. 14-23.
7. Postwar Planning in Industrial New England. By Dudley Harmon. Pp. 24-34.
8. Water Supplies for Air Raid Fires. By Horatio Bond. Pp. 35-46.
9. Water Supply Equipment and Facilities for Advance Bases of the U. S. Navy. By Charles T. Dickeman. Pp. 47-50.
10. Water Supply at Advance Bases of the U. S. Navy. By D. H. Bennett. Pp. 51-54.
11. Bromine and Chlorine Dioxide as Water Disinfectants. By Joseph A. McCarthy. Pp. 55-68.
12. Failure of Lower Reservoir Dam, Belfast, Maine. By J. Elliott Hale. Pp. 69-73.
13. Application of the Pitometer to Water Distribution Systems. By E. Shaw Cole. Pp. 74-83.

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25. Dozen Different Kinds of Water Delivered by New Plant. By William S. Lozier. Pp. 394-396.
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19. The Water Supply of Greenville, S. C. By John L. Hawkins. Pp. 131-134.

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11. Making a Water Works Work (Joliet, Ill.). By Joseph Whalen. Pp. 81-82.
12. Emergency Water Supply Program. By Harold E. Watson. Pp. 85-87.

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4. *p.* Drafting Consumer Rules for Water Services. By Max K. Socha. Pp. 207-208.

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8. Edmonton's New Water Softening and Filtration Plant. Pp. 17-19, 52, 53, 60.
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6. Maintenance of Machinery Under Today's Conditions. By J. D. McConnell. Pp. 30-42.
7. Ground Water in the Halifax Area, North Carolina. By Jasper L. Stuckey. Pp. 43-54.

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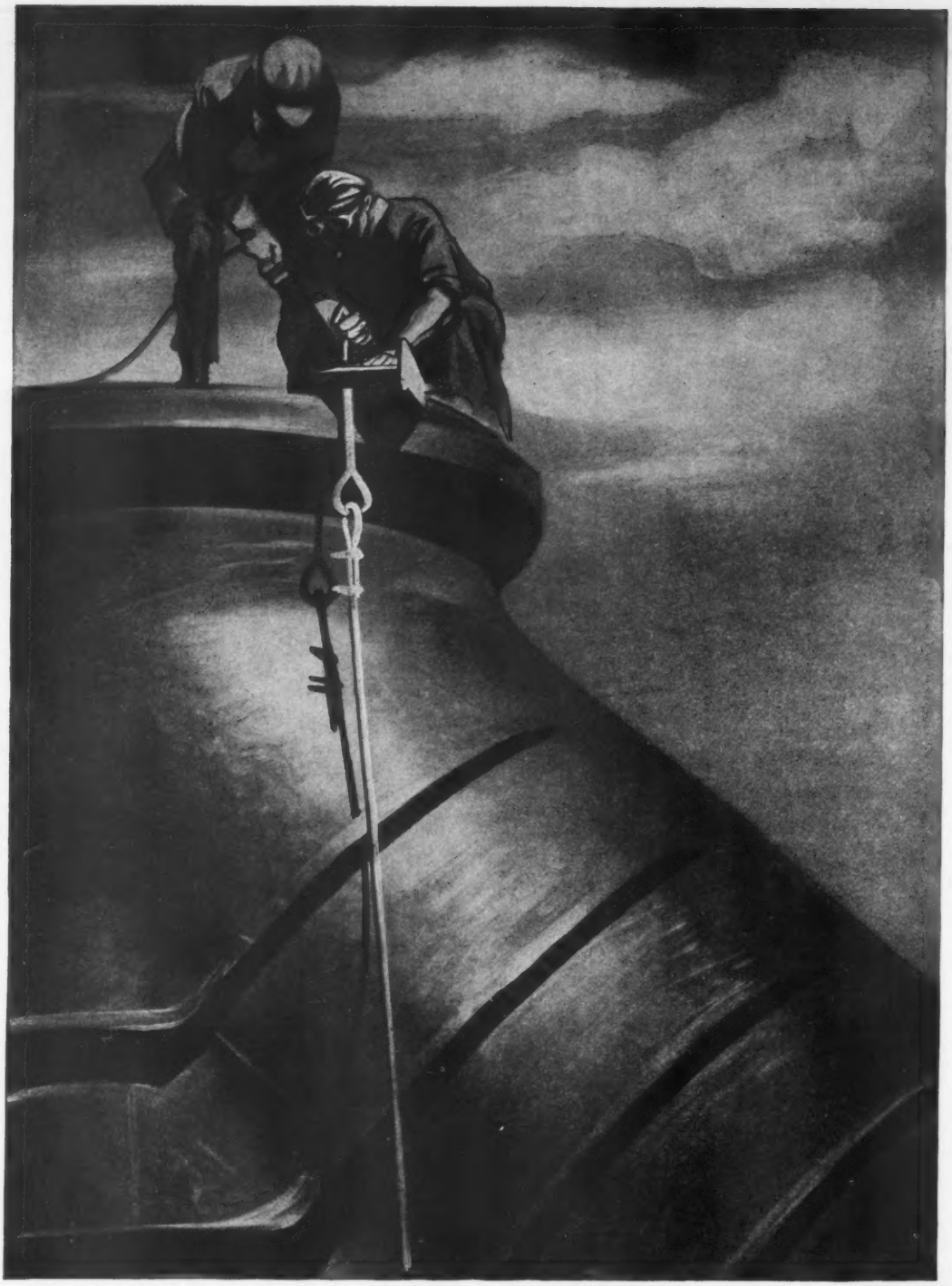

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Entrance gate to Princeton, N. J. sewage treatment plant.

The Sewerage Digest

Abstracts of the main features of all important articles dealing with sewerage and sewage treatment that appeared in the previous month's periodicals.

Applications Of Chlorine

Well established uses of chlorine are disinfection, B.O.D. reduction, and the control of odors and septicity. Others more recently developed include control of activated sludge bulking, correction of trickling filter pooling, thickening of sludge, and removal of grease; which have proven to be thoroughly successful in some installations, of indifferent benefit in others, and useless or worse than useless in still others. Its potential uses for the control of saprophytic bacteria, for reaction with organic mattter, and for chemical oxidation may make important contributions to plant operation. Treating wastes containing cyanide compounds seems to be impracticable by biological processes, but chlorine now is used successfully as a chemical oxidizing agent to destroy cyanides in wastes from certain war industries. Evidence indicates that the action of chlorine may be modified and controlled by applying it (1) in conjunction with air for more uniform distribution and reaction with organic matter; (2) as a hypochlorous acid after passage through limestone to remove the hydrochloric acid; (3) in mixture with lime, to provide an alkaline reaction instead of an acid one; (4) after reaction with iron or zinc, to limit its action upon organic matter.[C43]

Modified Sewage Aeration

This is a process of partial sewage treatment intermediate between primary sedimentation and high-rate single-stage filters or activated sludge. Any degree of treatment between sedimentation and activated sludge appears possible by controlling the air supply, the aeration period, and the amount of returned solids. For partial treatment, low air supply and small tank capacity are needed and dense excess sludge will be produced. For more complete treatment, a greater air supply and tank capacity are needed and a less dense excess sludge will be produced. The treatment apparently reaches a critical value when the aeration tank suspended solids exceed 600 to 800 p.p.m.[C46]

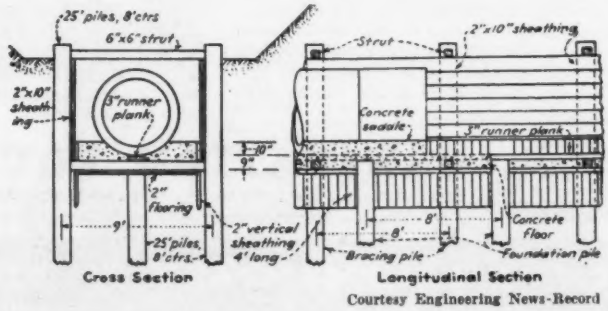
Constructing Sewer In Wet Alluvial Soil

In constructing 10 miles of 30" to 48" outfall at Memphis, Tenn., four of the five contractors did trench excavation with a dragline, the fifth with a hoe. One length of 200 ft. was in very fine, wet alluvial soil, 90% of which passed a No. 100 sieve. Laying the pipe on a timber floor proved impracticable, and the plan adopted was as shown in the illustration. Piles were driven 8 ft. apart in a row along each side, and the earth between them excavated, struts and horizontal sheathing being placed as the trench bottom was lowered. Then foundation piles were driven 8 ft. apart along the center line, vertical sheathing plank driven inside the horizontal sheathing to prevent any soil entering, and a tight floor placed beneath the lower struts. Then a runner plank was laid along the center line, the sewer pipe laid on it, and 1:2:4 concrete placed to a depth of 10" above the runner plank.[E9]

Removing Grease From Army Camp Sewage

Experiments on army camp sewage having a grease content of from 25 to 250 ppm indicated that the vacuum flotation process may be used to advantage in the removal of grease. The sewage is first saturated with air mechanically or by diffusion, and then is placed under a vacuum, causing a super-saturation of the sewage, when the air is released in a myriad of fine bubbles which adhere to particles of grease and other organic matter and cause it to float. (Fine bubbles are found to be far more effective than large). The air is released at the surface of the liquid, where the scum is collected mechanically. Pilot plant tests indicate that by this method 45 to 67% of the petroleum ether-soluble matter may be removed, depending upon the strength of the sewage. Coagulants, such as alum, ferric chloride and paper pulp, would increase the amount removed. Aero-chlorination was found to have no effect on the removal of grease by this method. The experiments indicate that removals obtained without the addition of any chemical should be satisfactory so long as primary sedimentation follows the vacuum flotation unit.[C47]

Many Army sewage plants have had heavy blankets of grease scum form on digesters and have tried disposing of it by burial, burning or drying on beds, none of which is acceptable for general practice. Most satisfactory digestion of grease is obtained where the primary digesters are provided with either high-speed mechanical stirrers or sludge recirculation into the scum zone, and at the point of entrance of raw sludge into the digester. Only by thorough dispersion of grease particles with raw and seed sludge can the operator be reasonably free from grease problems. In oxidizing processes, grease requires a longer period of aeration and a larger percentage of other solids. Plain settling is one of the most effective means of removing grease from raw sewage. Diffused air aeration has no appreciable effect on increasing the grease removal accom-



Courtesy Engineering News-Record

Method of constructing sewer in unstable soil in Memphis.

plished by plain settling, even with 5 to 10 ppm of chlorine gas added to the air. Mechanical aeration increased the removal of grease a few percent when in raw sewage in concentrations over 100 ppm; no increase was obtained by aero-chlorination with 5 ppm of chlorine gas. Vacuum flotation increased the removal a few percent when the grease in the raw sewage was over 150 ppm, and was not increased by aero-chlorination with chlorine up to 25 ppm. (However, at Lancaster, Pa. 38% removal by settling alone, 50% by aeration and settling, and 80% by aero-chlorination and settling was reported in 1938). Chemical treatment can remove practically all grease.[C48]

Small Treatment Plants in Ontario

In Ontario, the septic tank is almost the universal choice for private dwellings where no sewers are available. The liquid capacity should equal a 24-hr. flow for small tanks, a 12-hr. flow for large ones. Estimates of flow suggested are 50 gpd per capita for residences, 15 for schools, 100-175 for hospitals, 75-100 for institutions, 20-30 for factories, 25-50 for civil camps, 75 for military camps and hotels. Sludge should be removed from a tank every two years. The effluent is generally treated in a sub-surface filter bed. For large installations, trickling filters may be cheaper and more satisfactory.[C50]

The U. S. Army has hundreds of septic tank-tile drain installations serving small outposts. Many tile fields have been installed in practically impervious soil and have had to be redesigned.[C53]

Sludge for Victory Gardens

Connecticut produces 18,000 tons of digested sludge cake a year. In 1942 farmers used not more than a third of this. In 1943 more than half of it was being used, the increase being due largely to getting the State Soils Dept. interested. Do not apply it too heavily —sometimes the heavier the application, the lower the yield. Springfield, Mass., gets enough heat from its digesters to dry all the sludge. Lime-conditioned sludge does not seem to add much to the alkalinity of the soil; it seems to be almost sterile, but applying it in the fall probably will remove all health hazards besides increasing the fertilizing results.

At Marion, Ind., the sludge was applied in liquid form (8.6% total dry solids), on more than 50 Victory gardens in the spring of 1943, at a charge averaging $1.50 for a 930-gal. tank full. Kankakee and Battle Creek also furnish liquid digested sludge. Ft. Wayne put 50% more sludge on gardens in 1943 than in 1942, and Hammond 10 times as much.[C51]

Necessity of Secondary Treatment

It may sometimes be possible to fit the stream to the effluent instead of the effluent to the stream. Lockport, N. Y., avoided the necessity of secondary treatment by diverting water from a canal to the sewage. Pennsylvania is working toward that end by developing reservoirs for that purpose. The Minneapolis plant was designed to provide for chemical treatment, or secondary treatment if necessary, but so far primary treatment alone has been adequate.

However, there was considerable opposition to this idea. Streams that now furnish adequate dilution may utterly fail to do so in a dry year. Population increase may make the dilution insufficient. There should be a wide margin of safety. As to cost, in Illinois complete treatment costs $1.00 to $2.00 per capita per year, or about $3.00 or $4.00 a family — less than it pays for toilet paper.[C52]

New York's Postwar Sewage Treatment Plans

New York City has appropriated $32,500,000 for planning postwar work estimated to cost $990,000,000, of which $82,000,000 is for sewage treatment. The city's complete program includes 17 treatment plants, of which 6 are now operating. When the postwar plans have been carried out, approximately 85% of the city's sewage will be treated. Of

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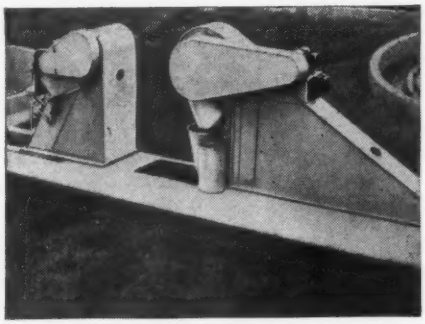

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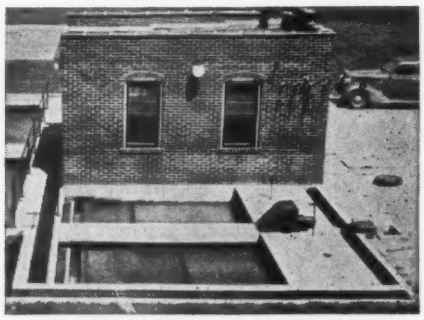
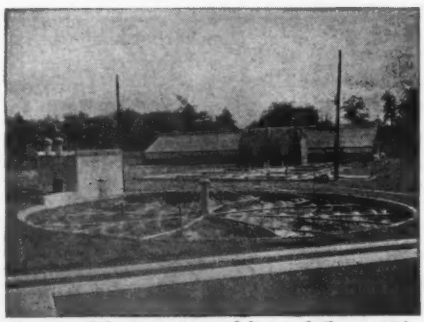


Small primary settling tanks equipped with Rex Conveyor Sludge Collectors.



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the proposed plants, three will furnish complete treatment by the activated sludge process. The final settling tanks will have the point of sludge withdrawal at the end opposite the influent, and the effluent weirs will be grouped at the influent end. At one plant, the sedimentation tanks will be completely enclosed so that all the air in them will be exhausted to a high stack, with provision for treating it with ozone, and the digestion tanks will have covers completely sealed. At the Rockaway plant the new principles of "modified sewage aeration" will be adopted. This process is similar to the normal activated sludge treatment except that the aeration-tank solids are kept in the low solids range; and while the sludge has an active biological life, it is not allowed to develop to the extent of having the normal activated sludge characteristics, with voluminous zoogleal masses and abundant ciliates.[L5]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

C — *Sewage Works Journal*
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43. The Chlorination of Sewage and Industrial Waste. By Harry A. Faber. Pp. 211-217.
44. Postwar Planning in Syracuse and Onondago County. By Glenn D. Holmes. Pp. 218-221.
45. Review of the Literature of 1943 on Sewage and Waste Treatment and Stream Pollution. By 12 members of the Committee on Research. Pp. 222-277.
46. Modified Sewage Aeration. By Lloyd R. Setter and Gail P. Edwards. Pp. 278-286.
47. Grease Removal by Vacuum Flotation. By Rolf Eliassen and H. B. Schulhoff. Pp. 287-295.
48. Grease Removal at Army Sewage Treatment Plants. By Rolf Eliassen and H. B. Schulhoff. Pp. 296-317.
49. Sewage Treatment Practice-Standards for Municipal Sewage Treatment Plants. By Arthur S. Bedell. Pp. 318-327.
50. Sewage Treatment for Homes and Institutions. By A. E. Berry. Pp. 328-332.
51. Use of Sludge in the Victory Garden Campaign. A symposium. Pp. 333-348.
52. Secondary Treatment—Present and Future. A symposium. Pp. 348-363.
53. Wartime Operating Problems in Municipal and Army Treatment Plants. A symposium. Pp. 363-372.

E — *Engineering News-Record*
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8. A Municipal Rate Schedule for Industrial Waste Treatment. Pp. 92-93.

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9. *c.* Sewer Construction Practice at Memphis. Pp. 97-100.

G — *Water Works & Sewerage*
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12. Three Years' Operation of the Gary, Ind., Activated Sludge Plant. By L. R. Howson and W. W. Mathews. Pp. 143-150.
13. A Sewage Plant Kink and a Gadget. By Bartley J. Cash. P. 151.

H — *Sewage Works Engineering*
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22. Biofiltration Plant Serves War Housing Project. By Rollin F. MacDowell. Pp. 226-227.
23. *p.* The Wartime Operation of Sewage Treatment Plants. By Langdon Pearse. Pp. 232-233.
24. The Discharge of Raw Sewage in the United States. Pp. 234-236.

J — *American City*
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9. Sewage Digesters Supply Gas for Domestic Consumption. Pp. 56-58.

L — *Civil Engineering*
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5. Postwar Sanitary Engineering Work for New York City. By Richard H. Gould. Pp. 184-186.

P — *Public Works*
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23. Gas Hazards in Sewerage Systems and Treatment Works. By A. Elliott Kimberly. Pp. 14-16, 42.
24. Chemical Treatment of Sewage as a Wartime Aid. Pp. 20-21, 26.
25. Use of Caustic Soda on Trickling Filters. By D. H. Hurst. P. 30.
26. *n.* A Typhoid Epidemic in Northern Indiana. P. 38.

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4. Sewage Treatment at Rocky Mount. By D. Y. Brannock. Pp. 66-74.
5. Municipal Rose Garden of Hickory, N. C. By P. L. Abernethy. Pp. 75-78.

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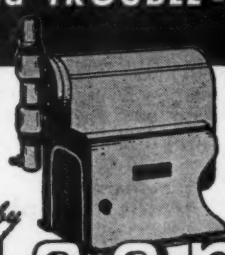

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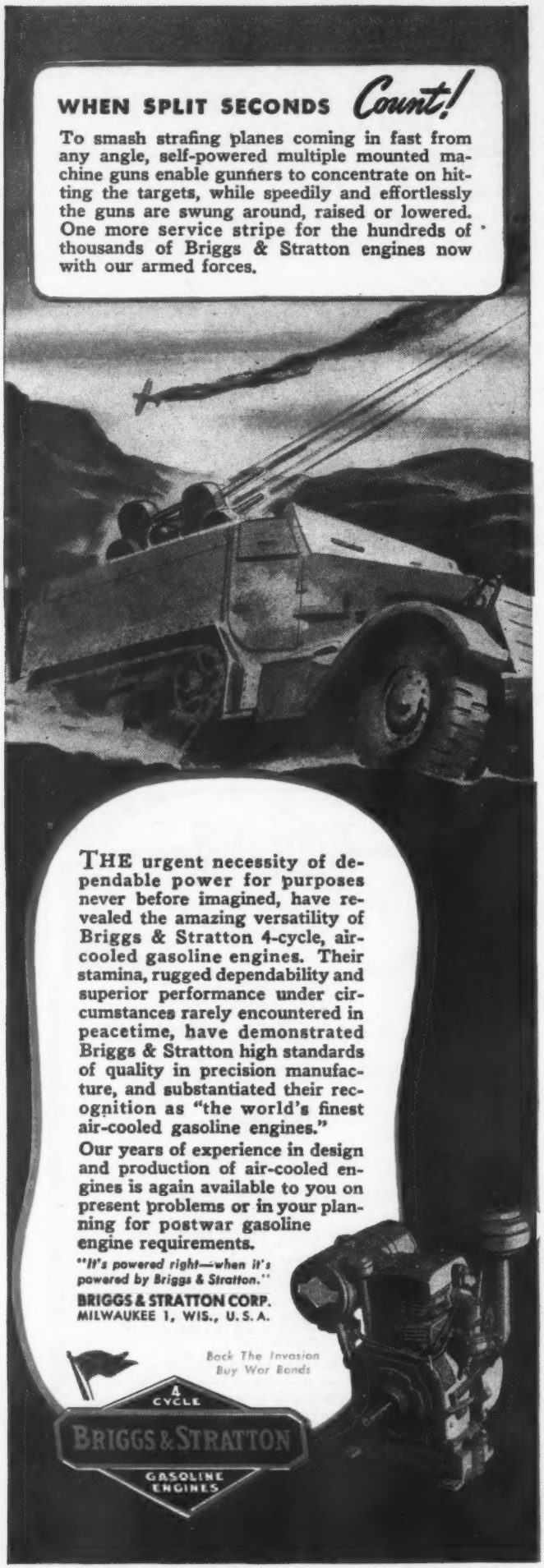
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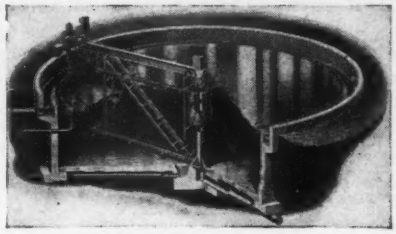

Link-Belt Collector for round tanks.

A New Collector for Round Settling Tanks

Link-Belt Company,
2045 W. Hunting Park Ave., Philadelphia 40, Pa.

A new sludge collector for the smaller-diameter settling tanks, to be known as the Link-Belt Type "B" Circuline Collector, is announced by Link-Belt Company.

A new 24-page illustrated data book No. 1982 is available in which photographs, dimensions, capacity tables and other pertinent engineering data are given for both Type "A" and Type "B" Circuline Collectors.

Where average domestic sewage is treated, the new Type "B" collector is recommended for tanks of up to 55-ft. diameter. Installations of Type "A" collectors in tanks of up to 115-ft. diameter, are illustrated.

In Circuline collectors, the settled sludge is collected and continuously moved radially, inwardly, on tank floor by a slow-moving scraper flight type conveyor and sludge plow, into a sludge hopper from which the sludge is withdrawn.

The conveyor is mounted on a power-rotated, centrally pivoted bridge spanning half the diameter of tank and having anti-friction-bearing equipped, resilient rubber-tired wheels at outer end of span, for smooth, easy travel on top of tank wall.

The entire floor area of the tank is cleaned of settled solids during each complete revolution of the bridge. This permits very slow rotation and insures that there is but a minimum of disturbance to the settling process and to the settled solids.

The sewage is introduced into center of the tank through a conduit under floor of tank, to assure an even distribution of flow throughout tank.

The drive, located at outer end of bridge span, consists of a motorized speed reducer carrying a sprocket wheel which engages a heavy galvanized tow chain located and anchored in the effluent trough. The outer end of bridge is pulled by this chain, or it might be said to "walk around" the chain.

When used in primary settling tanks, a screw conveyor is supported along the one side of bridge span, for the purpose of confining and more effectively moving the scum and grease to a scum trap. This feature prevents wind pressure from blowing the collected scum out of reach.

Atlas Duraplastic Air-Entraining Portland Cement

Universal Atlas Cement Company,
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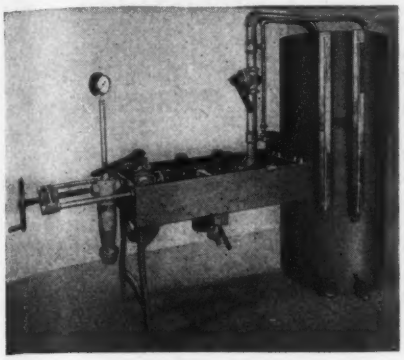
After research since 1935 in the laboratory and in the field, the Universal Atlas Cement Company announced the production of and since last year has marketed Atlas Duraplastic air-entraining portland cement for scale-resistant paving. According to the company, scores of

street and highway projects installed in more than a dozen states and cities provide conclusive evidence that Duraplastic air-entraining cement fortifies the concrete against the effects of freezing and thawing weather; renders the concrete highly resistant to scaling due to de-icing salts; tends to reduce manipulation scale. And extensive tests show that Duraplastic air-entraining cement requires less mixing water for a given slump; makes concrete more workable, more plastic, more cohesive, more uniform and more durable throughout; minimizes segregation and bleeding; and produces concrete that dumps, spreads, screeds and finishes more easily. It is called Duraplastic because it makes concrete more durable and more plastic.



Pittsburgh Meter Prover.

New Meter Prover

Pittsburgh Equitable Meter Co.
Pittsburgh 8, Pa.

The availability of a newly designed Meter Prover has been announced by the National Meter Division of Pittsburgh Equitable Meter Company. The manufacturer states that the National Prover has been constructed to conform with the ideas and needs of practical meter maintenance men and that accuracy, accessibility, ease, and speed in testing meters have all been incorporated in the design.

This prover will test, by the volumetric method, meters up to and including the 2-inch size. Flow rates are determined by an inbuilt Rate of Flow Indicator which is calibrated to accurately record flows of from 1/16 GPM to 160 GPM.

The two compartment, cylindrical tank, carries dual Percentage of Error Scales that are adjustable for calibration. These scales are graduated to read directly in percentage of error at four points. Nordstrom Lubricated Plug Valves are provided to control the flow.

Additional information on this National Meter Prover can be obtained by writing Pittsburgh Equitable Meter Company, Pittsburgh 8, Pa.

Airport Radio Equipment

Speaking before the New Jersey and South New York Sections of the International Municipal Signal Association Meeting at the Hotel Pennsylvania on Wednesday, April 19th, Ludwig Arnson, president of Radio Receptor Co., Inc., engineers and manufacturers of airway and airport radio equipment, declared that the operation of airports will be an important municipal function in the coming air age and that effective study of airport traffic control in all its branches should be started immediately.

"Airport traffic control may be defined as the control of the movement of any traffic within the confines of the runways of the airport and any services connected therewith, together with control of the air traffic within a specified limited area around the airport," explained Mr. Arnson. He went on further to explain that "up until this time the weakness of any system of airport traffic control has been that all forms of such control have been wholly dependent on the personal equation of those operating it. Control of vehicles on the runways can be obtained effectively only if they are equipped with transmitters and receivers, and it would be advantageous to have regulations to that effect."

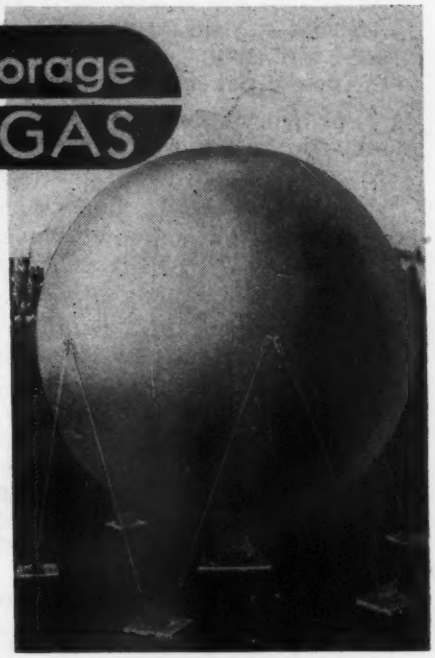
High Pressure Storage of DIGESTER GAS

The Stacey Brothers All-Welded High Pressure sphere is the answer to your problem of storing comparatively large quantities of sewage digester gas in the smallest practicable space. This modern holder combines utmost safety with pleasing appearance. Stacey Brothers spheres are built to the highest standards of design and workmanship by one of the oldest developers and producers of gas plant equipment.

If your plans call for the economical storage of digester gas—write us today.

THE STACEY BROTHERS
GAS CONSTRUCTION COMPANY

EXECUTIVE OFFICE: 5535 Vine St., Cincinnati 16, Ohio
EASTERN OFFICE: 21 West St., New York 6, N. Y.



The strong spherical shape blends harmoniously with surrounding buildings and landscape, and is ideal for residential and outlying districts where appearance is a factor and heights and areas of structures are limited.

Stacey Brothers All-Welded SPHERES
ENGINEERS · FABRICATORS · RECOGNIZED EXPERIENCE & FACILITIES

INCINERATION ENGINEERS
NICHOLS ENGINEERING & RESEARCH CORPORATION
60 WALL TOWER NEW YORK, N. Y.
Consultants · Designers · Constructors

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SHADOWBOX

WITH THE PAPER PROBLEM!

NO, SIR. Or with any other angle of the paper conservation problem. Our boys need every bit of paper and paper board the Army can get to ship their precious invasion supplies in. And it's up to you and every other good citizen to cut and cut and cut again on the use of paper and paper board.

For every time a convoy sets sail—that's so much more paper and paper board in action. And the supply, as you know, is diminishing.

So your job is to figure every known way, yes, and a few unknown ways, to USE LESS PAPER AND PAPER BOARD.

Don't worry about other people squawking about your cutting down. The big all-out national drive right now is selling the public on the necessity for paper conservation. They'll be with you.

The green light is yours. Step on it.

If your community has not already started Paper Conservation Committees, why not get them started now yourself?

Use Less Paper Because	Use Less Paper These Ways
Paper vests have proved excellent for aviators and ground crews as cold protection.	Condense letters and memoranda by (a) keeping margins as narrow as possible; (b) sticking to single-space forms; (c) using reverse side of incoming letters as first carbon copy of replies; (d) using reverse side of second sheets for carbon copies; (e) using both sides of all mimeographed sheets.
Paper is used for disposable gun covers and ordnance wraps to protect such equipment while making invasion landings.	Use smaller printed forms.
The Army supplies helmets of laminated fiber for non-combat duty in the tropics.	Make scratch pads from stocks of obsolete letterheads, memorandum forms, and other unused inventory.
Many essential airplane parts are fabricated of plastic with a paper base.	Control disbursement of paper supplies to employees so that excessive quantities do not accumulate in desks and departmental supply closets.
Army trucks require 20 pounds of paper for safe delivery.	
It takes 25 tons of blueprint paper to make a battleship.	

Let's All Use Less Paper

This advertisement prepared under the auspices of the War Advertising Council in co-operation with the Office of War Information and the War Production Board.

When writing, we will appreciate your mentioning **PUBLIC WORKS**

Continued Mr. Arnson, "The communications problem of the airport with its planes in flight is tied up with the regulations issued by Federal Communications. The airport itself, although in the past built and maintained by municipal funds, is only part of a system of air highways—it may be either a 'port of call' so to speak, or a terminal on this system or both. It has been stipulated by the CAA that airport traffic control in the air should commence at a distance of 30 miles from the airport, or ten minutes flight. This gives the airport not more than ten minutes to clear the runways. As traffic at an airport increases this time will have to be reduced and the tempo of operations increased.

"The CAA controls the airway traffic between airports both inter and intra state. This comprises a complete inter-communication and ground-to-air navigational and meterological reporting system. The situation is somewhat confused today because some of these airports are either wholly or partially controlled by the Air Forces. In normal times, however, all principal airports are on communications networks prescribed by the FCC. They are the red, blue, brown, green, purple, yellow and orange. The red network, for instance, is called the Northern Trans-Continental Chain and Feeders, and the principal airline using it is the United. There are twenty-two frequencies assigned to this network, ranging from 3147.5 kc to 141.22 kc. The control tower should be prepared to receive on at least three of these frequencies, any one of which may be required if the other two channels are occupied. It should be pointed out that there are any number of frequencies used by planes of all nations for aircraft on sea flight, distress signals, scheduled and off-scheduled routes, etc. Thus it will be seen how the airport is tied down to the airways system and functions as part of it.

"Like the airplane itself, the airport and its traffic control will have to accommodate itself to changing conditions in the postwar world. For instance, it is said that at the new Idlewild Airport there will be 13½ miles of runways. Hangar lines for airplanes will be six miles long, and for sea planes one mile long . . . altogether making it possible to handle 900 planes every 15 hours or one per minute. Three or four control points may become necessary. Tying these together, using all receivers and transmitters, will become a problem unless properly worked out. That, however, is for the future. Our job now is to study each project on a long-range viewpoint. Lots of experience has been gained . . . a number of helpful devices have been developed and progress is continuously going on."

General "in Action" on Invasion Front
General Supercrane Helping to Speed Invasion Preparations at an Undisclosed British Port

To meet demands for General Supercranes, plant and manpower facilities of Phillips & Davies, Inc. in neighboring Kenton have been enlisted by The General Excavator Company, Marion, Ohio, pioneers in the field of one-engine, rubber-tired, one man-operated heavy-duty cranes. Production is according to General specifications and is earmarked 100% for Uncle Sam.

In addition to all the features of regular models, Supercranes going into the war effort are equipped with a new Independent Boom Hoist. Not only does it assure faster operation, but it also adds to lifting capacity and stability. Furthermore, physical operations are greatly simplified because all motions are operated by a single lever, an especially important advantage in view of today's inexperienced operators.

"Phillips & Davies, Inc. are licensed to build Supercranes only for the duration," according to Sales Manager Don B. Smith, of General Excavator.

J. B. O'Connor Elected Executive Vice President of Dresser Mfg. Co., Bradford, Pa.

H. N. Mallon, President, announces election of three vice presidents of the company following a recent meeting of the Board of Directors.

J. B. O'Connor

J. B. O'Connor was made Executive Vice President, Arthur R. Weis and Lyle C. Harvey Vice Presidents.

Mr. O'Connor has been a Director of Dresser Manufacturing Company since August 23, 1938. He is also Vice President and General Sales Manager of Clark Brothers; Chairman of the Board of the Pacific Pump Works; and President of Bovaird and Seyfang, all subsidiaries of Dresser Manufacturing Company. A native of Augusta, Georgia, Mr. O'Connor attended the University of Georgia and served in the United States Army in the first World War. He joined Clark Brothers in 1927 as General Sales Manager and became a Vice President in 1935.

Mr. Weis is President of the Pacific Pump Works of Huntington Park, California, a Dresser subsidiary.

Mr. Harvey is President of the Bryant Heater Company of Cleveland, also a subsidiary.

C. P. Clark, President of Clark Brothers, who is already a Vice President of Dresser Manufacturing Company will continue to serve in that capacity.

Knowles Becomes Technical Director of Newly Formed General American Process Equipment

Dr. C. L. Knowles, Vice President of the Chemists Club and Director of the American Institute of Chemical Engineers, formerly with The Dorr Company, Inc., is now Technical Director of General American Process Equipment, a division of General American Transportation Corporation.

Dr. C. L. Knowles

Dr. Knowles' twenty years as Sales Engineer has given him an unusual background of practical as well as theoretical experience in chemical processes which will fit into the expanding process industries markets of the postwar period. This broad acquaintance will prove valuable in his work with General American Process Equipment which has recently acquired the plants and staffs of The Louisville Drying Machinery Co., the Conkey Company, the Turbo-Mixer Corporation and the American Machine Company. Dr. Knowles will be located at the New York office, 420 Lexington Avenue, New York.

Asphalt Institute Elects F. V. Widger Chairman Executive Committee

Five Vice Presidents for New Regional System

At their annual meeting the Board of Directors of The Asphalt Institute, representing the major part of the petroleum asphalt production industry of the United States and Canada, elected F. V. Widger of The Texas Company Chairman of the Executive Committee, with J. A. Blood, Standard Oil Company of California; F. R. Field, Standard Oil Company of New Jersey; A. M. Maxwell, Standard Oil Company of Ohio; H. B. Pullar, Berry Asphalt Company; D. D. Williamson, Talco As-

JAEGER "Sure Prime"
— Pumps that Exceed Their Promises

The only pumps that, for years, have been individually tested and certified for vacuum, capacity, pressure and regularly exceed their guaranteed performance — with up to 5 times faster 100% automatic priming, high capacity under adverse conditions, thousands of hours of extra service. Self-cleaning shells, replaceable liners, longest life seal, oversize shafts — for high pressures, continuous heavy service.

Sales — Rentals — Service in Over 100 Cities
THE JAEGER MACHINE CO., 400 Dublin Ave., Columbus, Ohio
CONTRACTORS' PUMPS, MIXERS, HOISTS, PAVING EQUIPMENT

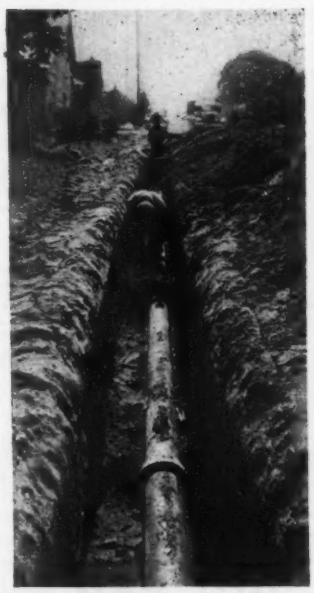
McWANE B&S WATER PIPE

for TRENCH poured joints

Every foot of McWane B&S pipe is Sand Cast

That's why it's so easy to handle — so easy to cut and tap. Beaded spigots make it easy to lay. Just the pipe you need to get quicker, trench-poured joints — and cut installation time and costs.

All sizes from 1¼" thru 12". Prompt shipments from stock.



All Sizes 1¼" thru 12"

Sand Cast Inside and Outside
McWANE CAST IRON PIPE COMPANY
BIRMINGHAM, ALA. SIZES 1¼" THROUGH 12"

NEW!

The *Bob White*

ELECTRONIC

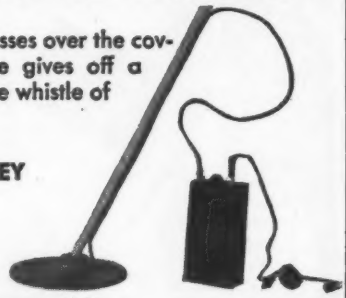
BOX LOCATOR

LOCATES ALL METAL UTILITY SERVICE BOXES AS FAST AS YOU CAN WALK!

When the loop aerial passes over the covered box, the earphone gives off a signal that sounds like the whistle of of a BOB WHITE.

SAVES TIME and MONEY
EASY TO OPERATE
SIMPLE TO HANDLE

Write for details



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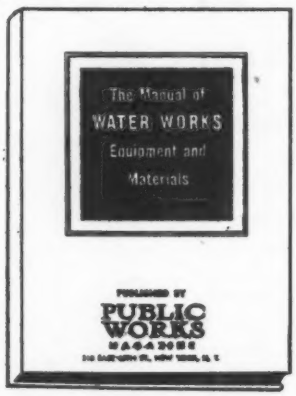
To Help You BLUEPRINT Now!



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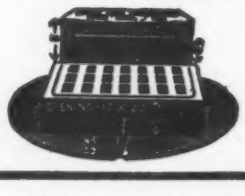
OUT THIS MONTH

STREET, SEWER AND WATER CASTINGS

Made from wear-resisting chilled iron in various styles, sizes and weights.



MANHOLE COVERS, WATER METER COVERS, ADJUSTABLE CURB INLETS, GUTTER CROSSING PLATES, VALVE AND LAMPHOLE COVERS

Write for Catalog and Prices

SOUTH BEND FOUNDRY CO.

Gray Iron and Semi-Steel Castings

SOUTH BEND, IND.

When writing, we will appreciate your mentioning **PUBLIC WORKS**

phalt & Refining Division, Southport Petroleum Company of Delaware; and H. R. Pauley, The Petrol Corporation, completing the Committee.

The five Vice Presidents elected, with their respective regional jurisdiction, were as follows: (1) Atlantic Seaboard-Southern, F. R. Field; (2) Ohio-Great Lakes, A. M. Maxwell; (3) Mid-West, H. B. Pullar; (4) Gulf, D. D. Williamson; (5) Pacific Coast, H. R. Pauley. Bernard E. Gray was re-elected as General Manager-Chief Engineer and Herbert Spencer, President of the Institute. George R. Christie, Standard Oil of New York was re-elected Secretary and Treasurer, with John N. Smith of the same Company continued as Assistant Treasurer.

Asphalt producing Companies newly elected to membership increased the total to thirty-eight, the largest number in the Institute's history. The new members are The Derby Oil Company, Wichita, Kansas; Lion Oil Refining Company, El Dorado, Arkansas; Skelly Oil Company, Tulsa, Oklahoma.

New U. S. District Engineer for New York District

Col. Edgar W. Garbisch, Corps of Engineers, is the new appointee. From his headquarters at 120 Wall St., he directs all aspects of the Engineers' military supply, military construction and river and harbor and flood control programs in the District.

Colonel Garbisch is a graduate of both Washington and Jefferson College and the U. S. Military Academy. He returns to New York after a tour of duty as District Engineer at Providence, R. I. Prior to that assignment he had served as executive officer to Col. A. B. Jones, his predecessor in the New York District and thus is thoroughly familiar with District problems. The territory in which he is responsible for operations of the U. S. Engineer Department includes metropolitan New York and Long Island, most of eastern New York State, northern New Jersey and western Vermont.

Viewing machines that employees of Worthington-Gamon Meter Co., Newark, N. J., used to set Army shell fuse production record are (l. to r.) Major George L. Cory, Robert R. Anderson, Vice-President and General Manager; and Lieut. Joseph Kahrs, Jr., USNR.

Army-Navy "E" Award for Worthington-Gamon

Citing employees of Worthington-Gamon Meter Co. for their "outstanding production of 75mm. shell fuses, one of the most difficult army ordnance items to produce," Major George L. Cory, Chief, Ammunition Branch, N. Y. Ordnance District, presented the Army-Navy "E" Award to the Worthington Pump and Machinery Corp. subsidiary at Newark. "You are doing a grand job," Major Cory said.

Fifth Link-Belt Plant Receives the Army-Navy "E" Award

On March 30, the San Francisco plant of Link-Belt Company, Pacific Division, was awarded the Army-Navy "E" for excellence in production of vital war material, making it the fifth Link-Belt plant to be thus honored.

"M" Pennant to Kennedy Valve Mfg. Co., Elmira, N. Y.

The pennant and Victory Fleet flag were presented at the company's plant by Charles E. Walsh, Jr., Director of Procurement of U. S. Maritime Commission who said in part: "There is no need for me to recount your accomplishments in detail. Despite the speed with which you have produced highly essential valves—there has been no sacrifice in the quality of your work—you have maintained your high standard in that important respect."

Harry A. Linch

The whole Dorr Company has been shocked and saddened by the untimely death, on April 29, of Harry A. Linch who has functioned as Manager of the Engineering Dept. since 1933. In that position he has initiated or collaborated in all the major mechanical developments of the company during the past decade. His ever friendly personality and wide fundamental knowledge of the engineering side of the process industries will be missed by his associates in The Dorr Company and his host of friends in the engineering profession.

Vernon Edler

Vernon Edler, vice president and general manager of the Peerless Pump Division of the Food Machinery Corporation, died May 1st at his home in Los Angeles. Born February 22, 1897, in Butte, Montana, he completed his education at the American School of Business and entered his commercial career as a sales engineer specializing in hydraulics. He entered World War I as a naval aviation cadet. After the Armistice he founded the Vernon Edler Corporation which merged with Food Machinery Corporation in 1929. He was appointed resident manager of the Corporation at Los Angeles and was elevated to the vice-presidency in 1935 when he became general manager of Peerless Pump Division, Los Angeles, Fresno and Canton, Ohio. He was widely known in pump circles and was instrumental in developing Peerless Pumps to a major position.

Vernon Edler

Conventions

June 13-16—American Water Works Association, Hotel Schroeder, Milwaukee, Wis.

June 21-22—Ohio Conference on Sewage Treatment, Hotel Harding, Marion, Ohio.

Sept. 19-22—New England Water Works Association, Poland Spring House, Poland Spring, Maine.

Sept. 24-27—American Public Works Association, Hotel St. Paul, St. Paul, Minn.

Oct. 3-5—Second Wartime Conference of the American Public Health Association, Hotel Pennsylvania, New York, N. Y.

Oct. 11-14—Federation of Sewage Works Associations, William Penn Hotel, Pittsburgh, Pa.

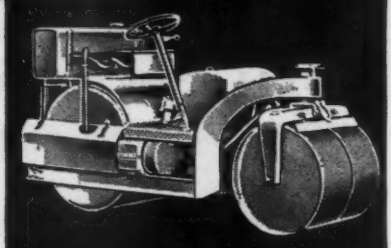
Oct. 17-19—Southwest Section of American Water Works Association, Stephen M. Austin and Driskill Hotels, Austin, Texas.

Oct. 24-26—California Section, American Water Works Association, Biltmore Hotel, Los Angeles.

T. R. Camp Opens Consulting Engineering Office

Thomas R. Camp, Consulting Engineer, has established offices in the Statler Office Bldg., Boston, Mass. His field of work includes water works and water treatment, sewerage and sewage treatment, and municipal and industrial wastes.

C. H. & E. CONSTRUCTION EQUIPMENT



3 Ton Tandem Roller

For maintenance patch work, and airports. Operates same as an automobile, with slow forward and reverse speed, controlled by one hand lever. Both front and rear rolls can be filled with water. Easy to load on a truck for transportation from job to job.

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Milwaukee, Wis.

Cafe Monaco

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HANNA BUILDING, CLEVELAND, OHIO

One of the most distinguished Restaurants between New York and Chicago

THE NATURAL MEETING PLACE FOR MIDWESTERN BUSINESS MEN

A VALUABLE TEXT FOR ALL WATER WORKS MEN

HYDRAULICS SIMPLIFIED

HYDRAULICS SIMPLIFIED is written in correspondence school style so anyone can understand it easily. As a matter of fact, hydraulics is not an exact science anyway. The actual flow in pipes may vary considerably from the results computed even by the most reliable formulas that have been developed. Moreover, the exact amount of water that will have to be carried is rarely known, and the sizes of pipes commercially available are limited.

Therefore, it is possible to use simplified formulas, tables that permit direct reading of answers to problems, and charts, which do not require a familiarity with higher mathematics but which will give results that are accurate enough for all practical purposes.

Contents Include:

Units of Length and Weight
Units of Liquid Volume
Volume—Time Measurements
Heads and Pressures
Limit of Accuracy in Hydraulic Computations
Hydraulic Definitions
Elemental Factors in Flow of Water
Hydraulic Terms and Usages
Factors Affecting Flow
Tables of Flow in Pipes
Computing Flows
Measuring Flows by Meters, Weirs, Orifices, Pitot Tubes, etc.
Discharge from Fire Hydrants

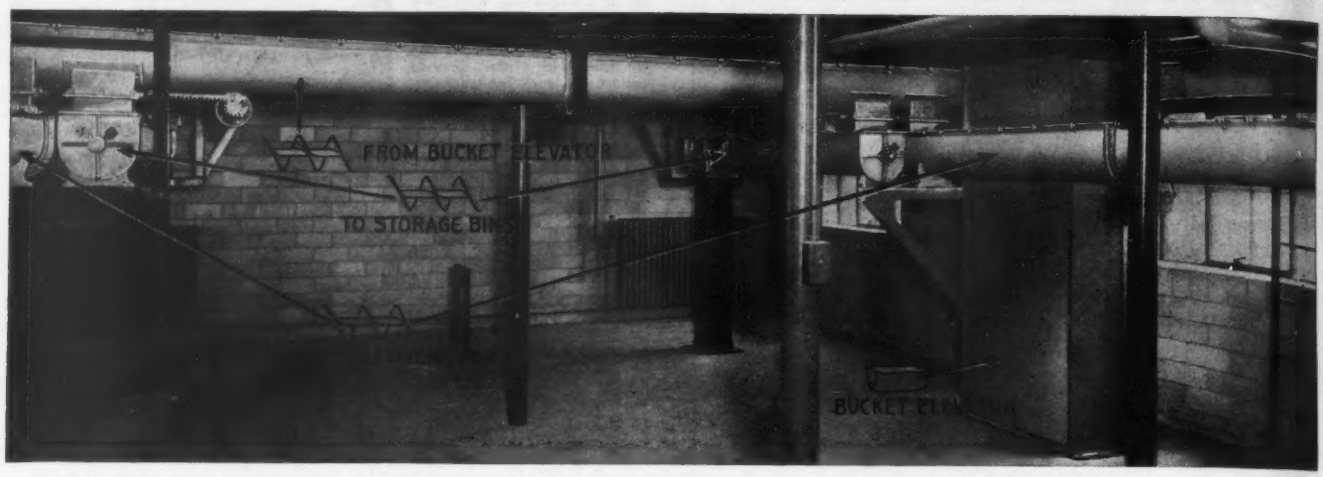
All computations are illustrated by practical examples given in detail. **HYDRAULICS SIMPLIFIED was published complete in the June, 1943, issue of PUBLIC WORKS. Send $1.00 for a reprint today. Money back in 5 days if not fully satisfied.**

PUBLIC WORKS Magazine, 310 E. 45th St., New York 17, N. Y.

When writing, we will appreciate your mentioning **PUBLIC WORKS**

HANDLING WATER TREATMENT CHEMICALS EFFICIENTLY AND ECONOMICALLY

at FALL CREEK PUMPING STATION of INDIANAPOLIS WATER CO.



Third floor—bucket elevator delivers to screw conveyor which in turn feeds two screw conveyors to water treatment plant and two to storage bins.

Compactness and cleanliness were two of the deciding factors in selecting a L-B Screw Conveyor-Bucket Elevator system for this modern station. This installation, in operation since 1941, represents a unique departure from the conventional manner of handling chemicals.

From R.R. car a suction system feeds material to a short screw conveyor, discharging into bucket elevator. Elevator raises chemicals three stories (about 45 feet) to screw conveyor, feeding four screw conveyors—two direct to bins in water treatment system and the other two into two storage bins. Thus the chemicals can be handled to process or to storage, as desired. The bottom of each storage bin has a side delivery slide gate which permits material to be discharged into screw conveyor discharging into the boot of elevator, so that the material can be taken to process when needed.

The drives on all units are L-B motorized reducers and "RC" roller chain.

Because Link-Belt builds all types of conveyors and power transmitting machinery, our engineers are unbiased in recommending the most effective combination for each application. Consult the nearest Link-Belt office.

LINK-BELT COMPANY

Chicago 8, Indianapolis 6, Philadelphia 40, Atlanta, Minneapolis 5, Dallas 1, San Francisco 24, Toronto 8. Offices and warehouses in principal cities.

BACK THE ATTACK — BUY MORE BONDS

LINK-BELT

ARMY E NAVY

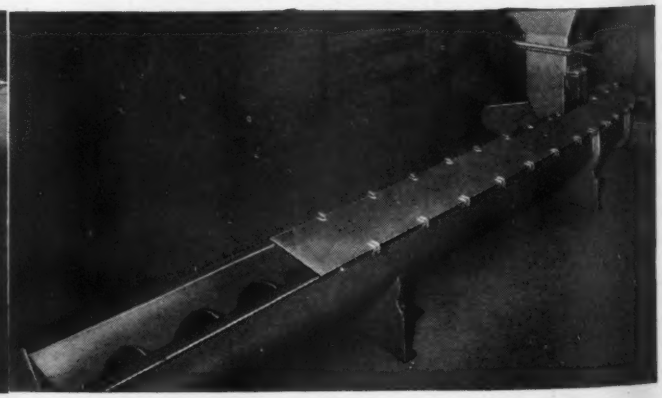
For excellence in war production

9608

ELEVATORS AND CONVEYORS

One of the screw conveyors delivering chemicals direct to water treatment plant.

Conveyor under storage bins delivers into another screw conveyor which empties into bucket elevator.



When you need special information—consult the classified READER'S SERVICE DEPT., pages 96-99

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Airport Radio Traffic Control

5. "Highways of the Air" is a new and valuable booklet available for engineers and officials interested in radio traffic control for airports. Illustrated and non-technical. Address: Radio Receptor Co., Inc., 251 West 19th Street, New York 11, N. Y.

Bins and Batching Plants

11. Good illustrations and useful data on all types of Heltzel Highway Bins, for truck mixer charging, bulk cement plants, enclosed bucket elevators, belt conveyors, etc. Heltzel Steel Form & Iron Co., Warren, O.

Cold Mix Plants

15. New catalogs and prices of Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus 16, Ohio.

Cold or Wet Weather Construction

18. Cleaver Aggregate Heaters and Dryers, Hot Water Boosters, and Automatic Steam plants are designed to speed up cold or wet weather construction. Write for illustrated bulletins. Cleaver-Brooks Co., 3112 W. Center St., Milwaukee 9, Wis.

Concrete Accelerators

31. New 48-page booklet in five sections explains clearly the effects, advantages and methods of using Calcium Chloride and Portland Cement mixes. Complete and packed with practical information; well illustrated; pocket size. Sent free on request by Solvay Sales Corp., 40 Rector St., New York 6, N. Y.

Concrete Curing

33. 64-page manual of concrete curing with calcium chlorides. Complete, handy. Contains useful tables, well illustrated. Write the Columbia Chemical Division, Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh 19, Pa.

Concrete, Early Strength

38. 64-page manual tells how to speed up year 'round concreting, shows how to secure high early strength and greater workability at temperatures either below or above freezing. Contains many actual examples of practical concreting operations; well illustrated with more than 60 photos, charts, graphs and tables. Calcium Chloride Assn., Penobscot Building, Detroit 26, Mich.

Concrete Mixers

44. Catalog and prices of Concrete Mixers, both Tilting and Non-Tilt types, from 3½S to 56S sizes. The Jaeger Machine Company, 400 Dublin Ave., Columbus 16, Ohio.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI PLATE pipe and arches — for culverts, sewers, subdrains, cattlepasses and other uses are described in a 48-page catalog entitled "ARMCO Drainage Products," issued by the Armco Drainage Products Association, Middletown, Ohio, and its associated member companies. Ask for Catalog No. 12

Generators

80. Two portable generators, one for AC and the other for DC current are described in new bulletin issued by Homelite Corp., Port Chester, N. Y. Commonly used for operating electrical equipment in planes, tanks and trucks, or to charge batteries or to supplement batteries for starting main engines, etc.

Forms, Curb and Gutter

91. Curb and Gutter and Sidewalk Forms. Many types available, including battered face curb form especially for modern traffic conditions. Heltzel Steel Form & Iron Co., Warren, O., will send booklets on request.

Finishing Machines

96. Flex-Plane Finishing Machines around the world. Handsome new folder shows various models in action. One machine combines screeding and longitudinal and transverse contracton joint installing. Available from Flexible Road Joint Machine Co., Warren, Ohio.

Graders, Patrol

98. The Austin-Western 99M Power Grader with its powerful all wheel drive simplifies all construction and maintenance; handles difficult jobs with economy and efficiency; and does better work on grading, ditching, scarifying, snow plowing, loading, mixing, bulldozing, shoulder trenching and backsloping. Write for Bulletin 1946. Austin-Western Co., Aurora, Ill.

Joints, Expansion

103. Joint Data. Expansion and contraction ribbon joint installers. Flexplane units and finishers. Catalog illustrates how machine installs both longitudinal and tranverse joints rapidly. Flexible Road Joint Machine Co., Warren, Ohio.

Mixing Plants, Asphalt

106. The Cleaver Asphalt Mixing Plant for an inexpensive plant mix and the Cleaver Tank Car Heater and Bituminous Booster are covered in illustrated catalogs sent on request by Cleaver-Brooks Co., 3112 W. Center St., Milwaukee 9, Wis.

Mud-Jack Method

107. How the Mud Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities — a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee 10, Wis.

Paving Materials, Bituminous

111. New "Tarvia Manual" is packed with useful data on how to build and maintain roads with Tarvia. Each step is illustrated with excellent action pictures. 64 pp 103 ills. Write to The Barrett Div., 40 Rector St., New York 6, N. Y.

Pumps

120. Interesting new booklet tells how to lengthen the life of your pumps. Explains how a little care will save a lot of wear. Write today for your copy. Homelite Corp., 2403 Riverdale Ave., Port Chester, N. Y.

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus 16, Ohio.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

124. 16-page illustrated bulletin, SP-37, describes and illustrates complete C. H. & E. line of self-priming centrifugal pumps from ½" to 8", including lightweight models for easy portability. C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee 12, Wis.

125. "Self-Priming Centrifugal Pumps," a 12-page illustrated booklet showing details of construction of Carter Pumps. Ask for Bulletin 4310. Address: Ralph B. Carter Co., Hackensack, N. J.

126. "Humdinger" 2- to 8-inch self-priming portable pumps. A 23-page illustrated booklet giving full details. Address: Ralph B. Carter Co., Hackensack, N. J.

Road Building and Maintenance

127. Two and Four Wheel Scrapers, Bulldozers, Tamping Rollers, Winches, Hoists and Repair Towers are subjects of special bulletins issued by Gar Wood Industries, 7924 Riopelle St., Detroit 11, Mich.

128. Two powerful Galion motor graders designed to answer every requirement for more speed in road, airport, dam and housing construction work are fully described in a folder illustrated with many action pictures. Issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

129. Warco Hydraulic Control Motor Graders, Duplex Hydraulic Scoops and Whizzard, easily transported, rollers are described and illustrated in literature available from W. A. Riddell Corp., Bucyrus, Ohio.

130. BG Maintainer, a powerful, speedy, low-priced machine for light road maintenance. Write for folder. Huber Mfg. Co., Marion, Ohio.

131. Speed Scoop. A versatile small scraper unit, ideal for emergency repairs. Illustrated folder issued by Huber Mfg. Co., Marion, Ohio.

Rock Drill Maintenance

132. New booklet presents through amusing cartoons useful hints on proper rock drill maintenance methods—what your men can do to get more work out of your tools with a minimum of expense for repairs and compressed air. Write The Cleveland Rock Drill Co., 3734 East 78th St., Cleveland 5, Ohio.

Rollers

133. New Tu-Ton roller of simple construction for use in rolling sidewalks along highways, playgrounds and other types of light rolling is fully described in a bulletin issued by C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee 12, Wis.

138. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio.

139. "Ironeroller" 3 Axle Roller for extra smooth surfaces on all bituminous work. Booklet contains roller data and operation details. The Hercules Roller Co., Bucyrus, Ohio.

140. This well-illustrated 16-page catalog describes the tandem, autocrat, cadet, and roll-a-plane rollers, and explains what each is intended to accomplish. Write Austin-Western Co., Aurora, Ill.

141. Three-Wheel Rollers. Huber Automative type rollers in 5 to 8 ton sizes and Huber 10 & 12 ton diesel rollers. New bulletins give full details and specifications. Huber Mfg. Co., Marion, Ohio.

142. Tandem Rollers. Variable weight tandem roller with three speeds forward and reverse for new highway surfacing and old road conditioning. Huber Mfg. Co., Marion, O.

Rotproofing

145. Cuprinol, a rotproofing chemical that protects wood from fungi and insects, yet has no offensive odor, is non-poisonous, does not corrode metal and can be painted over. Full details in booklet from Cuprinol, Inc., 7 Water St., Boston 9, Mass.

Soil Stabilization

150. "High-Service, Low Cost Roads" is one of the newer booklets using an effective combination of picture and text to set forth the principles and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated 24 pages. Sent by Solvay Sales Corp., 40 Rector St., New York 6, N. Y.

152. The Columbia Chemical Division will be glad to furnish to anyone interested complete information dealing with Calcium Chloride Stabilized Roads. This literature contains many charts, tables and useful information and can be obtained by writing Columbia Chemical Div., Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh 19, Pa.

154. "Soil Stabilization with Tarvia"—An illustrated booklet describing The steps in the stabilization of roadway soil with Tarvia will be mailed on request by The Barrett Division, 40 Rector St., New York 6, N. Y.

Spreader

187. Jaeger Paving equipment, including Mix-in-Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers, Adjustable Spreaders, Forms, etc.—4 complete catalogs of latest equipment in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus 16, Ohio.

Surface Consolidation and Maintenance

188. Detailed and illustrated presentation of the method and procedure in consolidated operations; explains how sub-soils can be conditioned to resist softening and frost action; how surfacing can be consolidated to provide smooth all-weather riding surfaces; how they can be maintained so as to prevent disintegration and gravel loss. Write the Calcium Chloride Association, Penobscot Bldg., Detroit 26, Mich., for Bulletin No. 29.

Transits and Levels

190. Transits, levels, and drafting room supplies: New Catalog just issued. 56 pages giving full illustrated descriptions of surveying instruments and accessories. Address: Warren-Knight, 136 N. 12th St., Philadelphia 7, Pa.

Wellpoints

195. New complete catalog, "Griffin Pointed Wellpoint Facts," just issued. Covers pre-drainage, describing wellpoints jetting pumps, with tables, diagrams and illustrations. Griffin Wellpoint Corp., 881 E. 141st St., New York 54, N. Y.

Street and Paving Maintenance

200. "Blacktop Road Maintenance and Construction Equipment" — Asphalt and tar kettles, flue type kettles, spray attachments with completely submerged pumps, tool heaters, surface heaters, road brooms, portable trail-o-rollers, etc. These are all described in detail and illustrated. This modern and up-to-date equipment for blacktop airport and road construction and maintenance is based upon experience and engineering research over a period of 42 years. Write for Catalog R. Littleford Bros., Inc., 452 East Pearl St., Cincinnati 2, O.

Fire Apparatus

300. Detailed information and advice about specially engineered Ward LaFrance apparatus will be sent on request. Ward LaFrance Div., Elmira, N. Y.

Snow Fighting

Snow Plows

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Features, specifications and method of attaching. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Ice Control

351. "Make Icy Highways Safe for Traffic"—a new bulletin by Michigan Alkali Div., Wyandotte Chemicals Corp., Wyandotte, Mich., tells how to use calcium chloride for modern ice control.

Sanitary Engineering

Aero-Filter

356. Aero-Filter Design Data is given in a new 32-page catalogue. It contains information on Advantages of Aero-Filter Process, Single Stage vs. Multi Stage Treatment, Filter Loadings, Rates of Flow and Results, Filter Depths, Recirculation, Sewage Pumps and Pump Control. Approximately 15 pages of blue prints are included in this instructive catalogue. Write Lakeside Engineering Co., 222 W. Adams St., Chicago 6, for a copy.

Air Release Valves

357. Automatic Air Release Valves for water, sewage and industrial uses are described and illustrated in new catalog issued by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia 42, Pa.

358. Air Valves are the subject of Rensselaer Bulletin Q in which Air Release, as well as Air and Vacuum, types are described. Address: Rensselaer Valve Co., Troy, N. Y.

Analysis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use" is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York 6, N. Y.

Activation and Aeration

367. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20 pp. illustrated. Sent on request to Norton Company, Worcester 6, Mass.

Blowers

370. All interested in low cost air for sewage disposal will want a copy of this catalog describing operating principles and specifications of Roots-Connersville Aerating Blowers. Write to Roots-Connersville Blower Corp., 301 Valley Ave., Connersville, Ind.

Bodies, Special Truck

375. Gar Wood Hoists, and Bodies for every requirement including special bodies for sanitary refuse collection and for street sprinkling are illustrated and described in new catalog issued by Gar Wood Industries, 7924 Riopelle St., Detroit, Mich.

Chlorinators, Portable

379. Complete data on new portable chlorinator designed to meet emergency calls quickly and efficiently. Write Wallace & Tiernan Co., Inc., Newark 1, N. J.

380. "Emergency Sterilization Equipment," a new bulletin describing the advantages of Dual Drive Chlor-O-Feeders which can serve as either a permanent chemical feeder or as a portable emergency chlorinator. Order from Proportioneers, Inc., 96 Codding St., Providence 1, R. I.

Cleaning Water Mains

383. Water main cleaning by the National Method is title of 4-page folder describing methods and results obtained, with full data. National Water Main Cleaning Co., 30 Church St., New York 7, N. Y.

Cleaning Sewers With Own Forces

386. 32-page illustrated booklet explains how a city can clean its sewers and culverts with its own forces using the up-to-date Flexible Sewer Rod equipment. Illustrates and describes all necessary equipment. Issued by Flexible Sewer Rod Equipment Co., 9059 Venice Boul., Los Angeles 34, Calif.

387. Literature illustrating how cities, towns and villages using OK Champion Sewer Cleaners are doing a complete sewer cleaning job from street level. Three sizes of machines available in addition to full line of sewer rods and accessories. Issued by Champion Corporation, 4752 Sheffield Avenue, Hammond, Indiana.

Consulting Engineers

389. "Who, What, Why" outlines briefly the functions of the consulting chemist and chemical engineer. Covers various methods of cooperation, on different types of problems, with industry, with attorneys and with individuals. Foster D. Snell, Inc., 305 Washington St., Brooklyn, N. Y., will send a copy on request.

Feeders, Chlorine, Amonia and Chemical

391. Feeders of all types including Hypochlorinators, Reagent Feeders, Dry Chemical Feeders, Chlorinators and Ammoniators are available in a wide range of capacities for feeding all of the usual chemicals used in sanitation practice—manufactured by Wallace & Tiernan Co., Newark 1, N. J.

392. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc. % 96 Codding St., Providence 1, R. I.

393. New circular describes and illustrates the Var-I-Feeder, a new portable chemical feeder for water main sterilization, military use or other chemical treatment. Write Chem-Feeds, Inc., 77 Reservoir Ave., Providence 7, R. I.

399. Pulsafeeders. A flow-proportional liquid chemical feeder, reciprocating type, fluid motor driven. Operating parts completely isolated from the chemical being fed. Micrometer adjustment. For feeding against high or low pressure. Wilson Chemical Feeders, Inc., 211 Clinton St., Buffalo 4, N. Y.

Filters

402. How to increase the capacity of filters through use of Anthrafilt and complete data on use of Anthrafilt for filters and sludge beds is contained in a revised pocket Manual issued by Anthracite Equipment Corp. For free copy write H. G. Turner, State College, Pa.

Filters, Vacuum

403. For bulletins on Vacuum Filters for dewatering primary, activated, digested or chemical sludge, write The Conkey Co., 420 Lexington Ave., New York 17, N. Y.

Fire Hydrants

405. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using, issued by M & H Valve & Fittings Co., Anniston, Ala

406. See listing No. 436.

407. Fire hydrants which are floodproof, easy to operate and service are described in Rensselaer Bulletin W., formerly known as "Coreys." Address: Rensselaer Valve Co., Troy, N. Y.

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Flow Meters

409. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others—and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 6750 Upland St., Philadelphia 42, Pa.

Gas Holders and Digesters

411. Digesters and Gas Holders for efficient collection and storage of sewage gas are described in an interesting illustrated booklet issued by Graver Tank & Mfg. Co., 332 South Michigan Ave., Chicago 4, Ill.

412. If your plans call for economical storage of digester gas, write for bulletin on Stacey Brothers All-Welded, High Pressure Spheres that combine safety with pleasing appearance. Stacey Brothers Gas Constr. Co., 5535 Vine St., Cincinnati 16, Ohio.

Gates, Valves, Hydrants

413. Gate, flap and check valves; floor stands and fittings. New catalog No. 34 gives detail information with dimensions for all types of new full line. M. & H. Valve & Fittings Co., Anniston, Ala.

415. See listing No. 436.

416. Check valves of the Clear-Way, Quiet-Closing type which eliminate "Slam" are described in Rensselaer Bulletin V. Made in expanding outlet type, as well as straight-thru type, for bolting direct to pump discharge. Address: Rensselaer Valve Co., Troy, N. Y.

417. Rensselaer Gate Valves of high tensile strength, corrosion resistant iron are described in Rensselaer Bulletin X. Address Rensselaer Valve Vo., Troy, N. Y.

418. A new four-page folder on MUELLER-COLUMBIAN Gate Valves gives construction details, shows various types of gear drive mechanisms available, and has handy check list of dimensional data. Write Mueller Co., Chattanooga 1, Tenn.

419. Double-disc gate valves; hydraulically operated valves; air, check, flap and mud valves. Fire hydrants with sliding gate or balanced valve. A 32-page catalog. Ludlow Valve Mfg. Co., Inc., Troy, N. Y.

Gauges

421. The full line of Simplex gauges for filtration plants are illustrated and described in catalog issued by Simplex Valve and Meter Co., 6750 Upland St., Philadelphia 42, Pa.

Gunite

422. The advantages of Gunite for reservoir linings, steel encasement, sidewalls and roofs, waterproofing tanks, increasing strength of existing structures, lining sewers, etc., are illustrated in a 32 page catalog issued by National Gunite Corp., 420 Lexington Ave., New York 17, N. Y.

Laboratory Equipment

423. pH and Chlorine Control. A discussion of pH control and description of comparators, chlorimeters and similar devices. An 80-page booklet. W. A. Taylor & Co., 7301 York Road, Baltimore 4, Md.

Leak Finders, Water

425. "The Answer to Your Water Leak Problem" is title of 8-page illustrated booklet issued by S. F. Ferguson, 11 Hill St., Newark 2, N. J.

Manhole Covers and Inlets

429. Street, sewer and water castings in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., Lafayette Boul. and Indiana Ave., South Bend 23, Ind.

Meters, Venturi

432. New bulletin illustrates Builders Air Relay system of transmission for the Venturi Meter which is particularly useful for liquids containing suspended solids like sewage. Eliminates corroson, clogged pipes, etc. Write Builders-Providence, Inc., 9 Codding St., Providence 1, R. I.

433. "The Selection of Main Line Meters," a highly informative and useful presentation prepared by a competent engineer, J. C. Thoresen, describes forms of differential producers and quickly solves typical problems with the use of graphic charts. Write Builders-Providence, Inc., 9 Codding St., Providence 1, R. I.

Meters, Water

434. Six types of iron case cold water meters built for the duration, but to last for years are illustrated and described fully in folder issued by Pittsburgh Equitable Meter Co., 400 No. Lexington Ave., Pittsburgh 8, Pa.

435. "Watchdog" water meters, made in standard capacities from 20 GPM up; frost-proof or split case in household sizes. All parts interchangeable with present models of same manufacturer. For bulletins, write Worthington-Gamon Meter Co., 282-296 South St., Newark, N. J.

Pipe, Cast Iron

436. Handbook of Universal Cast Iron Pipe and Fittings, pocket size, 104 pages, illustrated, including 14 pages of useful reference tables and data. Sent by The Central Foundry Co., 386 Fourth Ave., New York 16, New York.

437. Cast iron pipe and fittings for water, gas, sewer and industrial service. Super-deLavaud centrifugally-cast and pit-cast pipe. Bell-and-spigot, U. S. Joint, flanged or flexible joints can be furnished to suit requirements. Write U. S. Pipe and Foundry Co., Burlington, N. J.

438. "Cast Iron Pipe and Fittings" is a well illustrated 44 page catalog giving full specifications for their complete line of Sand Spun Centrifugal Pipe, Fire Hydrants, Gate Valves, Special Castings, etc. Will be sent promptly by R. D. Wood Co., 400 Chestnut St., Philadelphia 5, Pa.

439. McWane Precaulked Joint Cast Iron Pipe, in all sizes from 1¼ through 12 inches for water and sewage, equipped with various type of factory-made joints, as well as B. & S. joints. Illustrated booklet issued by McWane Cast Iron Pipe Co., Birmingham, Ala.

Pipe, Lock Joint

440. Lock Joint Reinforced Concrete Sewer Pipe. Pressure Pipe, Culvert Pipe, Centrifugal Pipe and Subaqueous Pipe is described and illustrated in bulletins available from Lock Joint Pipe Co., Ampere, N. J.

Pipe, Transite

442. Two new illustrated booklets, "Transite Pressure Pipe" and "Transite Sewer Pipe" deal with methods of cutting costs of installation and maintenance of pipe lines and summarize advantages resulting from use of Transite pipes. Sent promptly by Johns-Manville Corp., 22 East 40th St., New York 16, N. Y.

Pipe Joints, Water

443. Bellmaster Joints for simpler, faster, easier joining of cast iron pipe are illustrated in a new folder that gives full data on this self-contained mechanical joint. Write Dresser Mfg. Co., Bradford, Pa.

Pipe Joints Sewer

444. How to make a better sewer pipe joint of cement—tight, minimizing root intrusion, better alignment of joint. Permits making joints in water-bearing trenches. General instructions issued by L. A. Weston, Adams, Mass.

Pipe Joint Compounds

446. The uses of Tegul-Mineralead for bell and spigot pipe and G-K Sewer joint compound are described in a 16-page illustrated booklet issued by Atlas Mineral Products Co., Mertztown, Pa. Includes useful tables for estimating quantities needed.

Pumps, Sludge

447. Carter Sludge Pumps are described in 8-page illustrated bulletin, including specifications and tables. Address Ralph B. Carter Co., Hackensack, N. J.

448. Non-clogging, vertical or horizontal, dry pit or submerged; storm water and drainage pumps are described in several Bulletins; alo sump and bilge pumps. Dayton-Dowd Co., Quincy, Ill.

Pumps and Well Water Systems

449. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Advertising Dept., Layne & Bowler, Inc., Box 186, Hollywood Station, Memphis 8, Tenn.

450. Peerless pumps in a variety of types, with oil or water lubrication and any power drive, to pump water from any depth are described and illustrated in new literature that clearly shows their construction and special features. Write Peerless Pump Div., Food Machinery Corp., 301 W. Ave. at 26th St., Los Angeles 31, Calif.

451. Oil lubricated turbine pumps with open impellers. Five types of heads available. Specifications and illustrations in new bulletin 6930M-2 issued by Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill.

452. Centrifugal Pumps of various designs—single-stage, double-suction, split casing; single-stage single-suction; two-stage opposed impeller; three-stage; high-pressure; fire pumps; close-coupled. A bulletin for each type. Dayton-Dowd Co., Quincy, Ill.

Meter Setting and Testing

454. The most complete catalog we have seen on setting and testing equipment for water meters—exquisitely printed and illustrated 48-page booklet you should have a copy of. Ask Ford Meter Box Co., Wabash, Ind.

Screens

456. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and Inclined types). Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia 40, Pa.

Sludge Drying and Incineration

458. "Disposal of Municipal Refuse." Complete specifications and description including suggested form of proposal; form of guarantees; statements and approval sheet for comparing bids with diagramatic outline of various plant designs. 48 pages. Address: Morse Boulger Destructor Co., 205-P East 42nd St., New York 17, N. Y.

459. Recuperator tubes made from Silicon Carbide and "Fireclay" Corebusters for maximum efficiency are described and illustrated in bulletin No. 11 issued by Fitch Recuperator Co., Plainfield National Bank Bldg., Plainfield, N. J.

460. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes—a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Nichols Engineering and Research Corp., 60 Wall Tower, New York 5, N. Y.

Softening

462. This folder explains the process of Zeolite water softening and describes and illustrates the full line of equipment for that purpose made by the Graver Tank & Mfg. Co., 332 So. Michigan Ave., Chicago 4, Ill. Includes flow charts, tables and other valuable data. Write for a copy of this instructive folder.

463. Water Softening. The use of the Spaulding Precipitator to obtain maximum efficiency and economy in water softening is described in a technical booklet. Permutit Co., 330 W. 42nd St., New York 18, N. Y.

464. Infilco Accelerators for softening, clarifying and stabilizing. Write today for bulletin 1824. Infilco, Inc., 325 West 25th Pl., Chicago 6, Ill.

Sprinkling Filters

466. Design data on sprinkling filters of Separate Nozzle Field and Common Nozzle Field design as well as complete data on single and twin dosing tanks, and the various siphons used in them, for apportioning sewage to nozzles. Many time-saving charts and tables. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago 13, Ill.

Swimming Pools

468. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

Taste and Odor Control

470. "Taste and Odor Control in Water Purification" is an excellent 32-page, illustrated booklet covering sources of taste and odor pollution in water sup-

plies and outlining the various methods of treatment now in use. Every water works department should have a copy. Write Industrial Chemical Sales Div., 330 Park Ave., New York 17, N. Y.

471. Technical pub. No. 207 issued by Wallace & Tiernan Co., Inc., Newark 1, N. J., describes in detail taste and odor control of water with BREAK-POINT Chlorination, a method of discovering the point at which many causes of taste may be removed by chlorination with little or no increase in residual chlorine. Sent free to any operator requesting it.

Treatment

475. Three types of clarifiers for sewage treatment are illustrated and described in a new bulletin issued by Graver Tank & Mfg. Co., 332 South Michigan Ave., Chicago 4, Ill.

476. "Safe Sanitation for a Nation," an interesting booklet containing thumbnail descriptions of the different pieces of P.F.T. equipment for sewage treatment. Includes photos of various installations and complete list of literature available from this company. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago 13, Ill.

477. All-steel Rotary Distributors, correctly designed for the small and medium sized sewage plants, are the subject of a new, well illustrated booklet issued by Graver Tank & Mfg. Co., 332 South Michigan Ave., Chicago 4, Ill. This booklet also covers distributors for various types of high-rate trickling filters.

478. New booklet (No. 1642 on Link-Belt Circuline Collectors for Settling Tanks contains excellent pictures; drawings of installations, sanitary engineering data and design details. Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia 40, Pa.

479. New 16-page illustrated catalog No. 1742 on Straightline Collectors for the efficient, continuous removal of sludge from rectangular tanks at sewerage and water plants. Contains layout drawings, installation pictures, and capacity tables. Address Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia 40, Pa.

480. New illustrated folder (1942) on Straightline apparatus for the removal and washing of grit and detritus from rectangular grit chambers. Address: Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia 40, Pa.

481. "Sedimentation with Dorr Clarifiers" is a complete 36-page illustrated catalog with useful design data. Ask The Dorr Company, 570 Lexington Ave., New York 22, N. Y.

483. A combination mechanical clarifier and mechanical digester, The Dorr Clarigester, is explained and illustrated in a bulletin issued by The Dorr Company, 570 Lexington Ave., New York 22, N. Y.

484. Preflocculation without chemicals with the Dorrco Clariflocculator in a single structure is the subject of a new booklet issued by The Dorr Company, 570 Lexington Ave., New York 22, N. Y.

485. Dorrco Monorake for existing rectangular sedimentation tanks, open or closed, is described and illustrated in a new catalog sent on request. The Dorr Co., 570 Lexington Ave., New York 22, N. Y.

488. "Packaged" Sewage Treatment Plants, specifically developed for small communities—100 to 3,000 population. Write for full description and actual operating data for this type of plant. Chicago Pump Co., 2438 Wolfram St., Chicago 18, Ill.

489. "Carter Controlled Flocculation" is title of illustrated folder available on request from Ralph B. Carter Co., Hackensack, N. J.

490. Small type Conveyor Sludge Collector and Skimmer, Grit Collector, Aero-Filter and other equipment for small sewage treatment plants are described and illustrated in bulletins available from Chain-Belt Co., 1722 West Bruce St., Milwaukee 4, Wis.

Underdrains, Trickling Filter

492. Illustrated bulletin describes the Natco Unifilter block of glazed, hard burned clay for underdraining filter beds. Write National Fireproofing Corp., Pittsburgh 12, Pa., for free copy.

Valves (See Gates, Air Release, etc.)

Waste Elimination

493. Full information on the Pitometer Survey—a complete check-up on your water plant to reveal hidden sources of waste—will be sent promptly by The Pitometer Co., 48 Church St., New York, N. Y.

Water Treatment

494. New special folders contain the latest information in High Test Calcium Hypochlorite, Caustic Soda, Soda Ash, or Chloride of Lime as manufactured by Hood Chemical Co., 1819 Broadway, New York. Write for desired folders, or use coupon in this section.

495. If you have a water conditioning problem of any kind, write Graver Tank & Mfg. Co., 332 So. Michigan Ave., Chicago 4, Ill., who manufacture all types of conditioning equipment and will be pleased to make recommendations.

496. "Use of copper sulphate in water treatment plants" titles informative booklet, with valuable data on chemicals, dosage, etc. Write Tennessee Corporation, Atlanta 1, Ga.

497. Ferri-floc Ferric Sulphate — a new, valuable booklet on coagulation for water and sewage treatment plants. Write Tennessee Corporation, Atlanta 1.

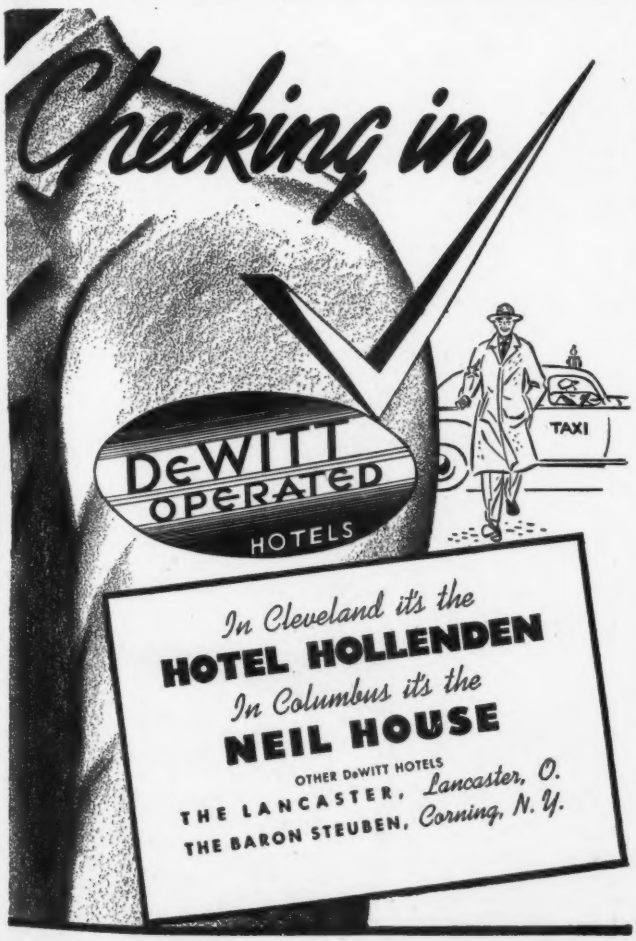
498. Bulletin describes stabilizing lime-softened water by recarbonation, discussing gas production, washing, compressing, drying, and applying the CO(2). Infilco, Inc., 325 West 25th Place, Chicago, Ill.

Water Service Devices

500. Data on anti-freeze outdoor drinking fountains, hydrants, street washers, etc., will be sent promptly on request to Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati 2, Ohio.

Water Works Operating Practices

510. "Important Factors in Coagulation" is an excellent review with bibliography and outlines of latest work done in the field. Written by Burton W. Graham and sent free on request to Stuart-Brumley Corp., 516 No. Charles St., Baltimore, Md.



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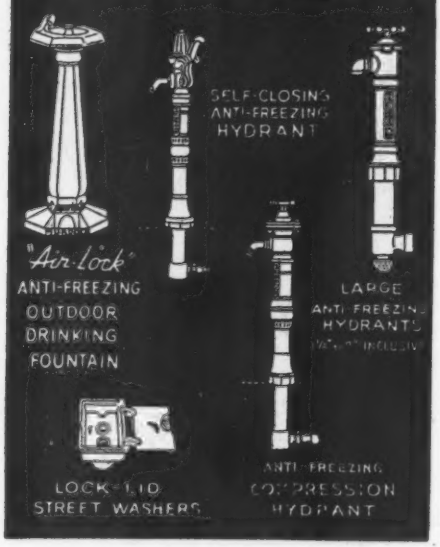

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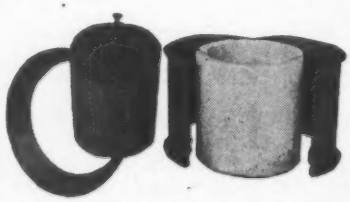
You can make excellent meter box barrels at low cost with one of these steel forms. They are made in several sizes and lengths.



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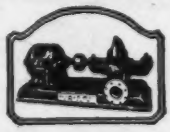

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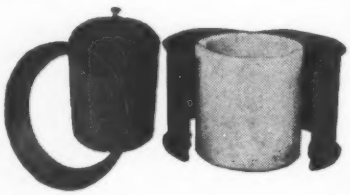

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